A language teacher's response to demands for reform in science education

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Preface

This paper represents work in progress for the UK Open University (OU) MSc course 'Contemporary Issues in Science Learning' (SEH806). Revised extracts from assignments electronically submitted to my remote tutor are here introduced and linked by short paragraphs in Italic.

1: My best primary and worst secondary UK school science learning experiences

SEH806 puts contemporary science learning issues into a constructivist perspective, recognising that, to some degree, even scientific knowledge is personally and socially constructed. Prior to an examination of the issues as manifest in professional debate in the UK, I here reflect on my own formative experiences as a science learner.

In the mid 1970s, 'there had been no requirement that primary teachers must teach science; the primary curriculum was largely school- and teacher-determined.' [Peacock, 2002:72] In retrospect, one primary school I attended maintained an exceptionally creative learning environment for science and communications technology, allocating significant and memorable time to their study.

In teams, we investigated topics we had chosen ourselves. Many involved environmental science issues (eg the oil crisis, conservation of species), driven by the political enthusiasms of popular young teachers, encouraged by the Head. Both productivity and creativity were rewarded - not individually, but through team points.

Each team worked together to score more points than its rivals, in a highly motivating atmosphere combining collaboration with competition. Teachers used their knowledge as facilitators, answering questions and guiding any practical work. In a weekly school radio programme, via an audio intercom system, teams would broadcast factual reports and creative stories to all classrooms. There, issues raised could be discussed, and further learning (using school library books) planned.

Other learning resources were good, including scientific (eg electronic) apparatus. I learned about series and parallel wiring by helping manufacture a team exhibit for Open Day: a UK wall map with keyed switches, different coloured bulbs lighting up different types of towns (seaside resorts, industrial centres, etc). Thus science was applied to other subjects, not just linked to them in theory. We felt proud switching different circuits on and off to impress our parents on Open Day, and even prouder when one failed but we improvised a repair *in situ*. Our new skills were enthusiastically transferred to out-of-school hobbies (eg Scalextric® car engine maintenance).

In contrast, Murphy's reflections on her 'entirely individual and isolated' [2004:17] learning of science at secondary school fit my worst experience. 'The teacher's role was over once the information had been handed over. Talking with other students was seen as wasting time and not part of the learning process.' [ibid] One chemistry teacher I had would hand out photopies of his poorly handwritten notes, then transfer chunks of them onto the board, reading aloud with his back turned to us. All we had to do was copy silently into our notebooks in class, then finish from his handouts for homework. An extreme case of bad teaching perhaps, but one exemplifying the systematic problems now under review in UK science education, where individual teachers must struggle to make a difference.

2: Recent demands for a national curriculum to promote 'scientific literacy' in UK schools

Having reflected on my own somewhat bipolar experiences of compulsory science education, I now review recent developments which put them into historical context. As an organising principle, I use a modified version of C.P. Snow's famous division of modern society into 'two cultures' (originally science and the humanities).

The UK is a developed democracy whose citizens can be arbitrarily divided into two cultures: a minority who produce science and technology, and a majority who consume these in everyday life. Regarding design and delivery of UK school science curriculae, two related questions arise.

1. To what extent does the consumer culture need educating in the esoteric ideas and practices of the producer culture?
2. Should the producer culture constitute an elite with the authority to answer 1.?

Answer 'Yes' to 2. and a glass ceiling appears, separating the 'objective' democracy of science (in which evidence based on *experiment* is good if a minority of peers can independently reproduce it) and the 'subjective' democracy of society (in which *arguments* based on *experience* are right if a dependent majority willingly suspends disbelief). Reflected in it are 20th Century conflicts of interest between the two cultures, over what kind of 'science-literate' citizens the 21st Century requires UK schools to nurture.

School curriculae are prescriptive, designed to transmit established knowledge and supervise developing skills. Even in a democracy, delivering a national curriculum for 'scientific literacy' requires an authoritative consensus: on *how* to assess literacy, in *which* sciences, begging questions about what 'science' is. A conflict arises between the producer culture's 'unproblematic common-sense realism' [Driver et al, 1996:20], in which science obtains 'knowledge of a real, physical, external world' [ibid]; and the consumer culture's appropriation of science as 'a social enterprise' [ibid:23], in which

'objective' knowledge becomes a 'subjective' democratic commodity, 'a collection of ethnosciences.' [Reiss, 2002:9] This is inherently problematic for pedagogues of 'scientific literacy' in multicultural Britain.

Learner-centred needs analysis is of merit in democratic curriculum design. Planet Science reports that UK students of all ethnicities perceive science as 'a fundamental feature of [their] everyday world,' one 'useful, relevant, and interesting.' [Cerini in OU, 2005] Evidently, UK students share international science's worldview, but feel alienated from it in school, where the science presented is *so* 20th Century: 'value-free, objective and detached.' [Millar & Osborne, 1998:2004] 21st Century students want stronger individual ownership of a broader, social issues-based curriculum; their teachers, creatively disenfranchised by National Curriculum test targets, agree: 'We'd like to teach in more exciting ways, but we don't know how.' [Cerini in OU, 2005; Thomas & Banks, 2004:27] This consensus on 'a very multi-faceted problem' [Reiss in OU, 2005] has recently attained critical democratic mass in the House of Commons:

> GCSE courses are overloaded with factual content, contain little contemporary science and have stultifying assessment arrangements. [...] Teachers and students are frustrated by the lack of flexibility. [HCSTC, 2002:5]

How did this crisis of confidence arise?

In the 1960s, the Nuffield Foundation prioritised the needs of the producer culture, 'that small minority of each age cohort' aiming for university science study. [Fensham, 1997:22] Its legacy was a curriculum which ignored aspects of science most meaningful to the consumer culture, such as 'individual and cooperative processes in the scientific community.' [ibid] In secondary schools, 'abstract concepts' [ibid] were emphasised, regardless of whether non-scientists might 'co-exist happily' [Thomas & Franks, 2004:9] with technology without them. In primary schools, though more learner-centred, this 'legacy curriculum' still emphasised processes reflecting 'a positivist and utilitarian view of what scientists do.' [Fensham, 1997:23] It seemed the

producer culture *had* answered 'Yes' to question 2.

Its 'science-centred' [Irwin, 1995] view also dominated promotion of lifelong learning for the 'public understanding of science' (PUS). A 1985 Royal Society report addressed educational failure with policies for 'a better-informed citizenry', but rejected 'critical evaluation of scientific institutions' [ibid:16]. Yet science's image was being 'tarnished' by 'unforeseen environmental and societal consequences' [Millar & Osborne, 1998:2004], and a view of 'science as ideology' was emerging to challenge 'the credibility and legitimacy' of scientific institutions. [Irwin, 1995:15-32] Through the glass ceiling maintained by the producer elite, the consumer culture was reflecting on its own 'unscientific' motivations, realising that scientists were self-interested citizens too. Their legacy curriculum was thus 'seriously misrepresenting' [Hodson 1998:9] the sociopolitical dimensions of science. A personalised curriculum for 'critical scientific literacy', linked to 'education for *political literacy*', was called for. [ibid:22]

Unsurprisingly, moves to politically correct school science were resisted by its producer elite. While they recognised social-psychological biases in their own labour, communicating these to non-scientists or even 'neonate science students' [Fensham, 1997:32] risked undermining its status. Yet scientists who broke ranks to popularise science inspired more neonates than the legacy curriculum. [Jenkins, 1999:17] Indeed, students were pursuing science post-16 'in spite of their experiences of GCSE rather than because of them' [HCSTC, 2002:5]. Furthermore, quantitative measures of PUS demonstrated public ignorance of 'the science which the scientific community thinks ought to be known.' [Jenkins 1999:13] By its own standards, the producer culture was failing to deliver.

The 21st Century labour market demands that UK producers and consumers of science alike exchange perspectives on scientific knowledge, to 'participate as citizens in a

democratic society.' [Millar & Osborne, 1998:2004] The glass ceiling is being demolished, and common ground sought between the two cultures, to lay the foundations in schools for a new 'citizen-oriented science' [Irwin, 1995:33].

In *Beyond 2000* [Millar & Osborne, 1998], the Nuffield Foundation brought Royal Society members and social science educators together to survey this new ground, recommending: 'The science curriculum from 5 to 16 should be seen primarily as a course to enhance general "scientific literacy".' [ibid:2009] This entailed a syllabus of 'ideas-about-science', delivered in 'explanatory stories', to help *all* students acquire 'an understanding of the processes of scientific enquiry.' [Thomas & Banks, 2004:13] The emphasis on scientific method in some of these stories would fit the legacy curriculum; but others are sociohistorical case studies, reflecting 'the complexities of applying scientific knowledge in real-world situations.' [ibid] To deliver the latter, the legacy teaching style - teacher as transmitting authority - must be transformed. But how?

When Collins et al asked scientists and science teachers what 'ideas about science' should be 'essential components of the curriculum for 5-16 year olds,' they of course ranked 'scientific methods and critical testing' highest [in Starr, 2005:6]. Perhaps more surprising was their second priority: 'creativity'. While the legacy curriculum arguably delivers the former, it is evidently failing to encourage the latter. Can its transformation be inspired by approaches to other subjects? Reiss argues that non-science teachers 'are better at treating young people as adults' [in OU, 2005], enabling them to engage more critically with other subjects than they do with science. Critical and creative engagement arises in contexts where students are *not* passive recipients of transmitted authority, but empowered to challenge *any* received wisdom by constructing arguments from differing points of view. This language-based approach is traditional to the humanities.

Can it be applied to science teaching? According to Hodson, it not only can but should:

> language-based activities can be utilized to explore, develop, extend, enrich and reorganize a student's personal framework of understanding. [...] What is at issue here is the shifting of emphasis from language as an instrument of teaching to language as a means of learning and a tool for thinking. [1998:154]

While the conventions of science communication in contemporary peer-reviewed journals may fashionably obscure it, this creative use of language has remained fundamental to the construction of scientific knowledge, as Montgomery elaborates:

> For a long time it was believed that something called "science" had the power to change language into a form of technology, i.e. a device able to transfer knowledge without ever touching it in any way. More recently, such beliefs have come under criticism by those who now stress that, rather than a piece of steely apparatus, scientific discourse is very much a living, evolving part of language generally, constantly engaged in the coining of new terms, in exchange with other areas of linguistic usage. Language is indelibly a cultural phenomenon, and science, in its major portion, is no less so.

But if 21st Century 'scientific literacy' demands a re-integration of Snow's two cultures in science education, a problem now arises: what 'proportionate weight' [Millar & Osborne, 1998:2020] should be given to 'legacy' components of 'citizen-science'? Conservatives fear 'the statutory requirement for pupils to learn ["hard" science] will be watered down' [Times Online, 2005], at a time when 'sixth-formers are already arriving at university without the depth of knowledge required.' [Blakemore in Starr, 2005] If the *Beyond 2000* curriculum fails to nurture the requisite quantity and quality of research scientists, how will the UK science-sector remain competitive in the globalised economy of the 21st Century? If it doesn't, it's also a problem for the reformers: who will fund the teacher-retraining and school re-equipment their new national curriculum requires?

We shall see. But since the 20th Century producer culture demanded 'scientific

literacy' of *all* its consumers, why shouldn't 21st Century citizens reciprocally demand 'sociopolitical literacy'? Logic does not dictate that, because the former failed to deliver, the latter will too. Besides, the original division between the two cultures was arbitrary, its glass ceiling now transparent to a 'citizen science' concerned with global *ecology* as much as with national *economics*.

Snow, as both scientist and novelist, understood the importance of creative literacy in both the construction and communication of scientific ideas. As both language teacher and science student, I now look for an integrated educational perspective on 'science as language'.

I suggest that a 'citizen-science for all' approach to a curriculum for 'scientific literacy' should borrow from the constructivist methodology introduced into language teaching (LT) by what in the 1970s was termed its 'communicative approach'. Based on extensive research into first- and second-language acquisition, often contradicting traditional pedagogical intuitions [cf Ellis, 1994; Lightbown & Spada, 1993], this approach transformed the design and delivery of primarily non-native *language* curriculae [cf Nunan, 1988 & 1995]. It did so in all the directions recommended for native *science* by *Beyond 2000*. Indeed, the global dominance of the international language of science in LT research and development has ensured that many curriculae in English for scientific purposes (ESP) now exist [cf Hutchinson & Waters, 1987]. While these may already be useful in multicultural UK contexts, where English is not necessarily the students' first language, perhaps greater promise exists in translating their methodological insights into science teaching for *native* English speakers.

Implementation in the UK of various EU Lifelong Learning imperatives has reflected recent rethinking along the pedagogical↔andragogical dimension in educational theory. In the EU's multilingual arena, LT has often played a pioneering role in the development of these imperatives. In contrast with the traditional pedagogical

emphasis on predetermined stages of childhood development, 1980s andragogy emphasised the significance of prior knowledge in new knowledge construction by *adults*. [Richardson, 2001] In 1990s open-learning contexts, communicative LT practitioners began applying such adult-educational principles to primary and secondary school language curriculae, empowering school students to exercise grown-up critical reasoning through problem-based learning (PBL). Conversely, the 1980s resurgence of vocational as opposed to academic educational pathways in the UK led to PBL science courses at UK universities, reminiscent of the best of primary science. [Thomas & Banks, 2005:33] Here, adult learners rediscovered childlike creativity in scientific study, often in social issues-related investigations. Shifts along this academic ↔ vocational dimension also transformed foreign language courses for UK university students, supported by ICT-delivered, open-learning modules. In all these developments, LT practitioners were often at the cutting edge.

Developments in LT theory and practice have liberated *language* students of all ages from the worst isolating experiences of formal learning, in ways fitting UK student demand for more motivating *science* curriculae. At the very least, its methodological insights must therefore be worthy of consideration in any curriculum promoting 'scientific literacy', which by definition entails communication of *science* as *language*. For teachers too, an approach which does not demand omniscient authority, but rather rewards discovery of scientific knowledge in collaboration with students, is intrinsically rewarding.

However, it must be emphasised that this new promise requires significant investment in educational infrastructure and human resources.

> Teachers are the key to developing and delivering a vibrant science curriculum. They must be consulted on any changes to the National Curriculum and assessment. They will need time, resources and training if they are to be able to implement change.
>
> [HCSTC, 2002:5]

3: Of science as language: a personalised view of learning and learners

Having identified ways in which 'scientific literacy' begs consideration of language teaching methodology for science education, I now set out to show how my own practice as a teacher, using science issues-based materials for language learners, seems justified in terms of the SEH806 literature. The emphasis here is on insights from English for Academic Purposes (EAP) at tertiary level.

First, I should confess that my approach to teaching is unorthodox, if judged by the pedagogical standards of the science education I received. These still prevail, albeit amid the above-cited demands for reform.[1] However, by the constructivist and social theories of learning which inform these demands, my approach is entirely conventional, tried and tested by decades of R&D in second language acquisition (SLA)[2]. For teenagers and adults, SLA suggests critical limits to traditional pedagogy.

EAP methodology is learner-centred[3], aiming from the outset to foster a classroom community of learning[4], facilitated by teachers as co-learners, rather than transmitters of authoritative knowledge in pre-determined stages. Language learning is recursive, demanding a 'spiral curriculum'[5], in which periodic regression to prior developmental levels measures good progress.[6] In EAP classrooms, the prior knowledge of students is a resource elicited equally by teacher and peers, to be recycled collaboratively across syllabuses packed with problem-based, discovery-oriented tasks.[7] The traditional distinction between passive (reading, listening) and active (speaking, writing) language skills is overthrown: reading, for example, is viewed as a purpose-driven interaction between writers and readers in shared-knowledge communities.[8] Moreover, the four discrete skills are integrated: email communication, for example, falls somewhere along a mode-continuum between speaking and writing. Typically, EAP task sequences activate all skills in multimedia knowledge contexts. Students may work in small groups, synthesising knowledge from different sources (journals, TV, Internet) for presentation to other groups in different modes (essays, seminars, online forums).

Rather than grading *language*, teachers grade *tasks*, so students encounter target structures or vocabulary in authentic contexts, 'scaffolded'[9] by language they know.

Institutional curriculae are flexible enough for EAP teachers to negotiate syllabuses with students, through an in situ process of needs analysis.[10] Courses are thus rendered personally motivating to students, using contexts relevant to their future professional studies. With this increased student ownership and control of learning comes increased responsibility. Learners cannot rely passively on teacher class-management, but must co-construct knowledge with teachers, who in turn must not be afraid to display lack of expertise in student subject domains. This doesn't mean EAP teachers abnegate *all* authority: they remain the language experts, transmitters of the last word on questions of appropriate usage. But it is the students who must raise these questions, through active exploration of the discourse of academic communities in which they aim to become communicatively competent members.[11]

In EAP practice, metacognitive awareness[12] of alternative learning strategies is essential if students are to transform their own.[13] EAP theory draws on both pedagogical and andragogical[14] notions of learner-difference, though its practice tends to emphasise transverse differences across adults. Where these are construed in *psychological* terms (eg visual versus kinaesthetic learning), the theoretical discourse may confuse *intra-learner* differences (eg between learning to read and learning to dance) with *inter-learner* differences (eg between learners who must read and learners who must dance to learn language). Fortunately, most EAP teachers are pragmatists who, however excited by a new theory, retain the common-sense to interact in their classrooms with people, not archetypes. But when learner-differences are construed in *sociological* terms, even this common-sense becomes problematic. By definition, EAP classrooms are multicultural. In them, political self-correction, influenced by relativist theories of cognition and language, becomes an occupational hazard. So when EAP teachers step out of class to do research, it is often into the constructivist paradoxes[15]

my traditional science education taught me to beware. If language is a social movement, which a grammar can only *describe* at one moment in its history, how should I *prescribe* correct future usage in class? If belief systems governing personal action are *all* intrinsically equal, how dare I discipline *one* student for inappropriate behaviour?

These dilemmas might suggest to scientific realists that teaching language is a job whose softheaded skills cannot be transferred to the teaching of hard science. One successful school science teacher dropped out of my first EFL training course, arguing that play-acting in class wasn't imparting knowledge as he understood it. Conversely, EAP teachers, trained to count teacher-talking-time (TTT) as cognitive oppression, feel uncomfortable when lecturing to (ie boring) passive audiences. My emergent position is that insights into learner-differences might sympathetically be applied to teacher-differences too. First, don't overpersonify: a difference between transmission-based and constructivist teaching methods shouldn't conjure up two archetypal teachers: one of science, one of language. Teachers are learners too: metacognitive awareness can motivate *them* to explore new teaching strategies, whatever their subject. Second, don't proselytise: when postmodern theorists claim to be the first to understand that scientific knowledge can't be empirically constructed or directly transmitted[16], they not only disrespect ancient wisdom, but ignore how much of their own prior knowledge was effectively transmitted to them. Like science, EAP has had its paradigm shifts, each differentiating itself in epistemological language games, inventing new names for old concepts, then denying ontological continuity. In part, this is dictated by competition for research niches: it is authors, not concepts, making new names for themselves. But there is a playfulness in these language games. Indeed, most EAP teachers are happily eclectic in putting new learning theories to the test in their classrooms, then integrating the bits that work into their prior expertise. If such willingness to learn from experiment makes language teachers like scientists, don't the language games played by science make its students like language learners?

In their preoccupation with scientific *literacy* as a learning goal, the science education reformers evidently think so.[17] Arguing that the language games[18] scientists play determine not just the communication, but the very *constitution* of the scientific world view[19], they now want teachers to mind their language in *science* classrooms. Inauthentic are narratives of science as heroic individualism[20]; fraudulent is the written style of scientific journals[21]; if these rhetorical games *must* be played, science students need metacognitive awareness of *how* and *why*. Decontextualised teacher-transmission of names, definitions and rules[22] no more leads to comunicative competence in scientific discourse than in any other language-learning context. So, empowered by unassailable evidence that traditional science education *is* failing (and *in its own terms*), educational reformers are encouraging science teachers to experiment with new classroom management strategies.[23] These, inspired by constructivist and social learning theories, are practically indistinguishable from those of EAP.

Hodson, for example, advocating a personalised approach to teaching and learning science, argues 'the very act of using language contributes to learning.'[24] Citing research critical of too much teacher-talk in science classes, he identifies 'unfamiliarity with language-based learning methods'[25] as problematic for contemporary science teaching. In emphasising 'the opportunity written material affords for supporting critical thinking'[26], and the ways 'talking about text' can improve *inferential* and *evaluative* comprehension', he promotes EAP-style 'mutually interactive'[27] skills activities to facilitate science learning. Hodson's cited acronym, DARTs (*'directed activities related to text'*[28]) could have come straight from an EAP manual, as could his advocacy of 'brainstorming' and 'free writing'[29]; likewise his concern that 'traditional emphasis on grammar, spelling and other technical aspects of writing can be enormously inhibiting.'[30] Even his arguments that 'a well designed and carefully used "refutational text"'[31] can be more useful than group discussion; or that TTT as a useful mode 'intermediate between spoken and written language'[32] can provide authentic listening input, echo down-to-earth EAP reactions against its own proselytisers.

Agreeing with Bruner that narrative storytelling should occupy 'a much more prominent place in the science curriculum', Hodson goes so far as to argue for 'extensive use of expressive and poetic writing in science', to reduce 'barriers that restrict access for girls and some ethnic minority groups.'[33]

People have always exchanged metaphors and myths to make sense of their world. Bruner suggests 'grand theories in science are perhaps more story-like than we had expected.'[34] When paradigm shifts occur, old observations are not discarded, but reinterpreted according to new metaphors, betraying the fact that 'the so-called data of science' were in the first place theory-driven: 'Light is neither corpuscular nor wavelike; waves and corpuscles [or particles ...] are in the mind of the theory makers.'[35] If our prior knowledge includes the "fact" from Psychology that our very perceptions are hypothesis-laden, Bruner's 'fictional science'[36] should make good sense. Scientists, however, are traditionally reluctant to trade ontological reference for metaphorical description. Working *within* paradigms, they must forget that 'stories can make sense but have no reference'[37]. Otherwise, why would paradigm shifts cause them such 'cognitive disequilibrium'[38]? Bruner admits that science "narratives" are 'highly constrained by the mathematical languages in which advanced theories are formulated', but suggests finding the right metaphor is the *really* hard work. Two dramatic 'discoveries' from the history of science serve to illustrate this: Bohr's idea of complementarity in Physics, and Kekulé's structure of benzene in Chemistry.[39] In both cases, metaphorical revelation came first, then eureka! The equations were easy to fix.

In presenting science as language to learners, neither Hodson nor Bruner seeks to relativise it out of existence, nor belittle the established successes of its prior teaching. Hodson resists the 'laudable motivation' of science educators who, for socio-cultural reasons, refuse to label children's unscientific ideas as 'misconceptions'[40]. Commitment to the belief that science offers progressively better ways of understanding their world is a binding incentive between teachers and learners. Bruner

recognises that his 'new' insights are really 'old hat' to working teachers, who've been putting them into practice since Socrates taught geometry in Plato's *Meno*.[41] But both writers acknowledge that there can be no *one* way of theorising the world, because of the metaphorical dimension of language description.

For scientists professing to unify ontological knowledge of objective reality, this significance of metaphor in science communication presents an uncomfortable paradox. When paradigms shift, concepts previously believed to denote hard reality suddenly turn into soft sociology: a 'dialogic imagination'[42] of 'plural conceptual schemes'[43] acquired through deliberate denial of 'cognitive dissonance'[44]. Given the investment of personal ambition and disciplined duty in any established science career, many otherwise good scientists initially dismiss great new science. Incontrovertible evidence that one's hard-earned prior knowledge is fundamentally flawed can scare the most rational out of their senses, even while knowing their threatened paradigm itself grew out of the flaws of precursors. For historians and sociologists, however, this acknowledgment that 'existing ideas are often strongly resistant to change'[45] means prioritising *affective* aspects of cognition[46], even when accounting for humanity's least subjective truths: those of science. Here are profound implications for the new personalised theories of learning which attempt to address failure in prior science teaching. But *where* should we look for *scientific* answers, if "science" is 'all in the mind'?

First, let's establish a fact. Even the most radical sociologists of science *do* litter their theories with ontological references they *really* believe in: to the names of theorists they think more or less knowledgeable than themselves. Dismiss Skinner[47]: what physical stimuli could have possibly caused him to think up Behaviourism? Challenge Freud[48]: what conscious observations could falsify Psychoanalysis? The *real* science of mind must lie in real brains. But is it still an *objective* natural science, like Newton's Physics; or are we now nurturing psychological *uncertainties* in pseudo-scientific

language? Our answers may depend on whether we dissect dead brains, or experiment together with living subjects.

Greenfield cites centuries of 'meticulous clinical observation' attesting how modifications to physical brain states simultaneously 'modify how people think and feel.'[49] But if mind is related to brain, the relationship is not 'a mere synonym'[50]. Attempts to map mental processes to 'specialised brain regions'[51] have failed to establish one-to-one correspondence. Instead, from the uterine environment to the circumstance of death, ever-changing neuronal configurations 'imperceptibly personalise the brain' so that individual experience 'becomes completely unique.'[52] This 'neuronal plasticity'[53] undermines any theory of learning predicated on categorical difference between nature and nurture, or on normal distributions of inherited or acquired traits (eg intelligence) across human populations. Nature and nurture become complementary metaphors in a mutually interactive duality, analogous to brain/mind or person/language. Maybe we must choose only half a dual metaphor to make pragmatic sense of local observations; but to think globally, we should keep one dialectical eye on the other.[54] Nowhere is this synthetic imperative[55] more self-evidently fundamental than in our observations and theories of language, 'the unique birthright of the species.'[56]

In one half of the story, Pinker plots an enormous wealth of multidisciplinary detail to narrate one big idea: that language is a *natural* instinct.[57] That there is another half, he is metacognitive of, since the English he speaks (and, with artifice, writes) is a language nurtured in some human communities, not in others. But his laudable aim being to challenge the dangers of fixation in that other half, we can suspend our disbelief in his evidence, and learn much about ourselves from his science fiction. First[58], damage to brain areas adjacent to the Sylvian fissure correlates significantly with language dysfunctions (eg Broca's and Wernicke's aphasias) which are *not* language-culture specific. Second[59], "normal" brained children, gifted with either

functioning vocal apparatus or the sensorimotor ablility to sign, acquire the grammar of *whatever* language culture they're raised in. Furthermore, their accelerated developmental output does *not* correspond to cross-cultural variations in quality or quantity of input (eg through 'motherese'). Indeed, children creatively reconstruct grammatical irregularities in their parent language (and turn pidgeons into creoles). Third[60], if neuronal pathways in children's brains are not sufficiently activated within a 'critical period' of language development, their capacity as adults to exploit their unique "instinct" is severely retarded. These three unencultured phenomena give weight to Chomsky's[61] argument for an innate grammar, *universal* to human language; although the phrases in which this is structured change continuously across generations (and, within one, across Chomsky's own books). The implications for first language *speech* acquisition seem to be: no *explicit* theory of teaching is necessary, or even tenable.

But let's not lose the plot. There is another side to this story, as told by Deutscher, who sets out 'to point to those areas in the structure of language for which there is no need to invoke innateness.'[62] Like other good science popularisers (eg Pinker), Deutscher uses fictional narrative devices to engage his readers, entitling his most elegant argument 'a mystery in five parts.'[63] In it, he demonstrates how apparently random generations of sociolinguistic "erosion" ('a haphazard sequence of effort-saving changes', eg vowel shifts) can interact with creative psycholinguistic "analogies" (products of 'the mind's craving for order', eg backformations), to evolve a self-evidently intelligent design like the Semitic verbal system.[64] Phonologically, it seems counter-intuitive that random variations in natural speech patterns could 'inject a vowel into a cluster of consonants'[65] to signify a word grammar change; yet this is a grammatical feature common to Semitic languages (eg Arabic). Deutscher's story of its creative construction needs no recourse to metaphorical mechanisms in individual brains. Nor, however, does it imply better ways to teach children to listen.

Had either Pinker or Deutscher referred to the artifice of *written* text, in which their theories (and ancient Semitic verb grammar) were first rendered *explicit*, they might have lent more weight to contemporary arguments for the *social* development of language. In the developed societies now concerned with educating citizens for scientific *literacy*, children start learning science (and mathematics) when they start learning to read and write. They are assumed already to have been natured or nurtured with sufficient speaking and listening ability to be engaged in the energetic recycling of teaching and learning which text constructs and conserves.[66] So while it is true that teachers in classrooms confront learner differences which raise empirical questions as to whether traits like "abnormality" and "genius" are organic in *nature*, teaching remains, in spirit, a *nurturing* profession. As such, it should be optimised by egalitarian ideals, which even when made explicit in authoritative texts, must still be accountable to democratic differences of interpretation in *real* educational practice, i.e. in supporting *real* learners.

For science as language, this means helping learners attain not only "literacy" in the traditional sense, but "communicative competence" to interact with each other, through multiple media in different science discourse genres. It should now be established that EAP methodology has much to offer science teaching in these respects.

4: Applying EAP methodology to the presentation of science narratives in social-issues based science learning

Having established a theoretical basis for the use of EAP methodology in the new science education demanded for the 21st Century, I now present an example from my own teaching practice. Lesson plans and materials are appended after the endnotes and bibliography.

In arguing that EAP significantly answers calls for reform in contemporary science education, I was aware that some shift away from empirical reference to metaphorical

description is entailed, if EAP methodology is to be applied to the teaching of science. Treating scientific discourse as significantly linguistic invites multiple personalised interpretations, not just between paradigms at the level of theoretical text, but within them at the level of individual words. So there are "buzzwords" in my above argument, of which different readers not disinterested in contemporary issues of science education might have different personalised interpretations. One of these is "narratives", a key term in the movement for a social issues-based approach to the delivery of scientific "literacy" to all citizens, through compulsory education and beyond into lifelong learning.

Among the radical reforms of school education suggested in the seminal *Beyond 2000* report[67] was the use of "stories" or "narratives" of science. Among the radical reformers cited in support of it was Bruner[68]. Yet it is clear that Bruner intends "narratives" to have a learner-centred sense, as a means by which teachers and learners can co-construct scientific knowledge; whereas *Beyond 2000* seems to view them still as a means of authoritative knowledge-transmission, just one more learner-friendly than traditional science texts. Though pedantic, this distinction does have implications for my argument that "narratives", as used in EAP-style learner-centred activities, might facilitate another of the *Beyond 2000* curricular reforms, the introduction of social issues-based science teaching at secondary level. If "narratives" are merely to serve as a disguised means of perpetuating the transmission of "definitive" scientific knowledge, the use of learner-centred EAP methodology in their delivery becomes inauthentic. Teachers will feel hypocritical, and learners will soon realise they are being deceived by the old dressed up in new hats.

Therefore, I would like to present a rationale for the use of "narratives" of science in Bruner's sense, using EAP learner-centred methodology, in a social issues-based curriculum setting. I am not a real science teacher, but through an example of how I have used a science narrative to promote communicative competence in adult EAP, I

hope to show how this might work in a secondary school setting. The EAP learners for whom I designed (and with whom I further developed) this sample teaching sequence study in mixed-level, multicultural groups, aged 18+. They are overseas students studying a range of arts, sciences and humanities at under- and postgraduate level at Bristol University. It seems reasonable to take them as representative of the multiple consumer and producer agendas for citizen-science learning subsumed under the umbrella "Science for all" in *Beyond 2000*. Given that English is not their first language, lowering their zone of proximal development[69] for communicative competence, it seems reasonable also to imagine secondary level native speakers (eg GCSE students) participating in and benefitting from similar social-issues based, science-as-language activities in comparable ways. But only if there is no hidden transmission and assessment agenda to the delivery of the science narrative in question.

My sample EAP teaching sequence (cf Appendices) is based around a BBC *Horizon* documentary narrative. This tells the story of how international scientists collaborated in identifying and understanding the phenomenon of "global dimming"; how their work met initial resistance from "global warming" experts; how peer-reviewed experimental method led to it gaining acceptance; and how interactions between "global dimming" and "global warming" now complicate the "climate change" issue, with implications for personal, governmental and corporate social responsibility. I am aware that TV documentary "narratives" raise fundamental questions regarding the "authentic" communication of "science" to nonscientist audiences[70], having written at length on this myself[71]. However, the "authenticity" of science "narratives" is not my curricular challenge here. The use of this episode of *Horizon* is entirely "authentic" in the EAP sense of being a genuine act of communication in the target language community. Moreover, its multimodal presentation, staged to incorporate a variety of other relevant multimedia resources,[72] is "authentic" both in EAP terms and, I believe, in terms of *Beyond 2000*'s suggestions for "social issues-based" science input in secondary schools

A further justification for the presentation of science "narratives" in this EAP style follows from my concern, shared with Hodson[73], that science teaching informed by postmodern educational theory should still offer students the opportunity to believe in science as a better way of understanding the *real* world (eg than religion). *Horizon*, as the BBC's science flagship, carries with it some of the authoritative status of "science", and transmits "real" scientific knowledge in ways also appropriate to traditional science classrooms. Simultaneously, engaging in science-as-language by exploring different voices in different discourse genres, students can explore the reconstruction of scientific knowledge in non-scientific domains, drawing their own conclusions about whether "science" really is "better". They should suffer minimal authoritative censure in the process, since no knowledge-content assessment is entailed in this EAP approach, whose emphasis is on communicative competence in social issues-based scientific discourse. They are, however, expected to argue with their peers!

The lesson plans (Appendix 1) and some associated materials (Appendix 2) for this sample teaching sequence demonstrate the range of integrated content presented, and integrated skills practised, throughout the learning process. They also indicate how teacher interventions 'to support internalisation of the scientific story by students are made *throughout* the teaching sequence'; and how responsibility is handed over by 'providing opportunities for students to "try out" and practise the new ideas for themselves' in a variety of multimodal communicative contexts.[74] However, I recognise that lesson plans on paper 'tend to focus upon the constituent activities and treatment of content,'[75] failing to convey the facilitating role played by the EAP teacher in class. This raises questions about teacher-difference which are difficult to research and thus hard to address in the design and evaluation of teaching sequences, whether of science or of language. Yet they must be addressed, given the differences between constructivist EAP and traditional science-teaching methodologies, if teacher-training programmes are to be developed to deliver the promise of the *Beyond 2000* curriculum reform in UK schools.

A further major problem remains if EAP-style teaching sequences like this one are to be promoted for science-as-language teaching in the secondary curriculum. As I have stated, EAP methodology assesses *not* subject-specific knowledge, but communicative competence in language (cf the discussion skills mock assessment in Appendix 2). Clearly, in native speaker schools, science-as-language assessment regimes would have different priorities, therefore need different criteria. Nevertheless, I have cited enough evidence [above] of demand from science education reformers for the kind of interactive, language-based negotiations which EAP routinely delivers, that I feel this example can serve some constructive purpose. If we can imagine a whole range of science-based information being input in schools in social issues-based contexts, in this EAP style; we can surely imagine science teachers, researchers and administrators collaborating to adapt it to existing assessment criteria, or those criteria to it.[76]

One last critical observation, this time related to EAP learner-centred teaching practice. Ideally, in collaborative activities (such as when groups each research different aspects of a main issue, then report back in new groups comprising one 'expert' from each of the old), students get the chance to demonstrate communicative competence both as constructive learners and, to some extent, as transmitting authorities. But managing such situations, even the most idealistic EAP teachers have to confront a real problem: learner-centred group dynamics are rarely egalitarian.[77] Dominant personalities may emerge from the first phase of such a group activity with the expertise to handle the second phase; those they have dominated, however, may not. This is demotivating for both learners and teacher, and difficult for the latter to manage, 'not working with one student at a time but with a whole class.'[78] Such challenges are intrinsic to and therefore endemic in constructivist teaching, and might demotivate traditional science teachers in retraining.

But as *Beyond 2000* clearly demonstrates, their traditional methods have problems too.

Endnotes

1 cf Millar & Osborne 1998 for a survey.
2 Ellis 1994
3 Nunan 1988
4 cf Brown 1997 on her FCL programme for 'thinking and learning about serious matters', which parallels EAP approaches to 86 'collaboration'.
5 Bruner 1996:91
6 cf Claxton in Hodson 1998:49 on how we 'laminate' levels of explanation for different contexts.
7 eg Cox & Hill 2004
8 Grellet 1981
9 Wood et al. 1976 in Bruner 1996:92
10 Nunan 1988b
11 cf McGinn & Roth 1999:104 '*educational aims*: towards competent participation'.
12 cf Brown 1997:76 'metacognition'.
13 Wenden 1991
14 cf Richardson 2001
15 cf Hodson 1998 Ch. 5
16 Driver et al. 1994:58 'not transmitted directly', 70 'scientific knowledge is discursive in nature'
17 cf Fensham 1997 for an survey of the international school science literacy movement.
18 McGinn & Roth 1999:106
19 Leach 1999:219
20 McGinn & Roth 1999:104-111
21 Medawar 1990
22 cf McGinn & Roth 1999:108 '*educational practice*: decontextualised vocabularies.'
23 cf HCSTC 2002 identifying failure in its own terms; Manners & Laing 2000 confronting teachers with evidence of failure and encouraging new strategies.
24 Hodson 1998:154
25 Hodson 1998:156
26 Hodson 1998:156
27 Hodson 1998:166
28 Hodson 1998:162
29 Hodson 1998:162
30 Hodson 1998:162
31 Hodson 1998:40
32 Hodson 1998:159
33 Hodson 1998:163
34 Bruner 1996:94
35 Bruner 1996:94
36 Bruner 1996:94
37 Bruner 1996:94
38 Piaget, in Hodson 1998:37
39 Bruner 1996:95 on Bohr, 96 allusion to Kekulé.
40 Hodson 1998:45

41 Bruner 1996:93
42 Bruner 1996:90
43 Driver et al. 1994:62
44 Festinger, reference unavailable at time of going to press.
45 Hodson 1998:38
46 Hodson 1998 Ch.6; cf Greenfield 2005 on the indistinguishability of emotion from consciousness.
47 Skinner, reference unavailable at time of going to press.
48 as did Popper, reference unavailable at time of going to press.
49 Greenfield 2002:44
50 Greenfield 2002:45
51 Greenfield 2002:51
52 Greenfield 2002:47-50
53 Greenfield 2002:49
54 cf Sfard 1998:12
55 contrast Kant's categorical imperative.
56 Greenfield 2002:52
57 Winder's *Independent* review, on Pinker 1994: back cover
58 Pinker 1994:307-313
59 Pinker 1994:266-283
60 Pinker 1994:290-296
61 Pinker 1994:89-125; cf also Maher 1996:77
62 Deutscher 2005:19
63 Deutscher 2005:183-209
64 Deutscher 2005:208
65 Deutscher 2005:201
66 Scientifically literate readers may detect here a hysteresis loopy analogy!
67 Millar & Osborne 1998
68 Bruner 1996
69 Vygotsky, in Leach & Scott 2000:87
70 cf Brown 1997, whose FCL programme integrates concerns about authenticity and narrative.
71 Hubbuck, P. (2007) 'Exploring issues of authenticity in the communication of science to the general publis, as exemplified by BBC TV's *Horizon' Mulberry* 50 pp. 101-132
72 cf Leach & Scott's recommendations for teaching sequence designs and their staging/presenting.
73 Hodson 1998
74 Leach & Scott 2000:84
75 Leach & Scott 2000:84
76 Let's meet somewhere in the middle!
77 cf Brown 1997:80 for the ideal; Manners (2000) for examples of the real problems with children.
78 Leach & Scott 2000:88

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APPENDIX 1 - Sample Lesson Plans

It is assumed that T. has shown Ss. how to join and use a *Yahoo!* group set up for this teaching sequence at: http://uk.groups.yahoo.com. Readers of this paper who wish to explore the teaching materials referred to below can do so as follows: go to http://www.yahoo.com; Sign In as usn: apuenglishviewer, pwd: apuapu; goto Groups; in My Groups select LCBristolG1; goto Files. There you will find a hierarchy of clearly labelled folders containing versions of the graphic, audio and video files required for the following teaching sequence.

Lesson 1: 2hrs

1) In people-friendly discussion space.

T. puts adjective 'global' in middle of whiteboard, Ss. brainstorm vocabulary associations in pairs. T. collects these in a whole-class 'scattergram' on board. Repeat this process with 'dimming'. (T. may need to input eg 'dimmer switch', 'he's a bit dim!'). Repeat again with 'global dimming'. T. tells Ss. they will watch a *BBC Horizon* documentary about this new phenomenon.

2) In big screen projection space.

T. projects excerpts A-F from *BBC Horizon* documentary *Global Dimming*. For each:

a) T. plays excerpt, Ss watch and listen intensively (no notetaking yet).
b) Ss. in 2s or 3s read questions on handout (Appendix 2) and discuss from memory. T. monitors, inputting language and guidance where necessary.
c) Second viewing: Ss. take notes.
d) Ss. quickly revise answers from b) using notes from c).
e) T. summarises answers with regard to misunderstandings arising in d) and to next excerpt.

3) Homework.

Ss. to research or suggest solutions to global dimming and predict what further problems their implementation might cause. Aim: prepare to discuss in groups before reporting to whole class in Lesson 2.

Lesson 2: 2hrs

1) In same groups & spaces as Lesson 1.

Groups discuss and then present to whole class their solutions and further problems (HW from Lesson 1). T. then plays *Global Dimming* excerpts G and H (task sequence as for A-F in Lesson 1) and leads whole class to eureka: implementing solutions to global dimming may exacerbate the problem known as global warming!

Next, T. hands out photocopies of *Independent* newspaper article in which scientist proposes an extreme solution to global warming (shoot sulfur into sky). Ss. skim read to find answers to following questions:

a) What solution does the scientist propose exactly?
b) What one problem predicted by his critics as likely to result from implementing his solution is explicitly referred to in the article?
c) What further problem can we infer from reading this article in the context provided by the *BBC Horizon* documentary we've been watching?

Whole class eureka: the main problem likely to be caused by implementing such a solution to global warming is an increase in the problem known as global dimming!

3) In same groups at shared computer monitors.

T. shows link to *Independent* article: http://news.independent.co.uk/environment/article1205975.ece

T. tells Ss. to imagine they work in the Science section of a newspaper with only 30 minutes to go before publication deadline. Task: each group to produce a media savvy summary of the global warming/dimming dilemma for their readers, to be posted as a Messages in the class *Yahoo!* group by the end of the lesson.

4) Homework.

T. edits S. articles using *MS Word* Track Changes, then returns them to Files section of *Yahoo!* group for Ss to check.

Lesson 3: 2hrs

1) Individually at computers then conferring in pairs/threes.

T. supervises solitary workthrough of audio-based EAP materials on corporate social responsibility. These were developed at Bristol University to improve non-native speaker awareness of emphasis and signalling techniques in English academic speaking. Ss. then collaborate on the following research/reporting tasks:

a) Think of any companies you know who might be part of the global warming/dimming problems and might therefore be expected to take corporate social responsibility for their actions.
b) Go online and research whether any of these companies (if not, any others?) are using the language of corporate social responsibility with regard to their environmental impact.
c) Post a message to the *Yahoo!* Group including links to the most interesting information you've found and a brief account of why you found it interesting/relevant.

3) Homework.

Online discussion: read the other groups' messages and reply with any comments/questions you have. Respond to any replies to your group's message. T. to incorporate extracts from texts linked to by Ss. into discussion task rubric for Lesson 4.

Lesson 4: 2hrs

1) In people-friendly discussion space, in two groups (ideally sixes or sevens).

A *Corporate Responsibility Discussion Task* handout using texts sourced by Ss online (Appendix 2) is distributed. Ss have 15 minutes silent reading time (T. permits no discussion yet).

A *Discussion Moves* handout (Appendix 2) is provided. Each group rehearses the given expressions aloud and elicits any other moves and corresponding language they might want to use.

T. explains that one group will observe and take notes while the other conducts its discussion. Observers receive a *Discussion Feedback* handout, containing the following observation task questions (with notetaking space):

Did everyone in the group contribute to the discussion?
Did group members encourage each other to speak?
Were a good range of 'moves' made as the discussion progressed?
Were the 'moves' clearly signalled by appropriate language?
Did you feel the discussion had a sense of direction?
Did the group draw the discussion to a coherent conclusion?

Was anyone persuaded to change their ideas during the discussion?

How could the group improve their next discussion?

Each observer will also monitor the discussion moves made by one individual, by drawing lines on a schematic of the observed group's seating arrangement (eg if student A speaks to B & C but not D, A's observer draws an arrowed line from A to each of B & C: B, C and D's observers only draw lines if B, C or D initiate a move in response). T. manages classroom so discussion group are seated with good mutual views of each other in circle or horseshoe, and each observer has a good view of the face of their observee.

Discussion, observation and feedback proceeds as follows:

a) Discussion group has 5 minutes' more preparatory silent reading time.

b) Discussion proceeds for 20 minutes while observers silently take notes.

c) Observers give collective feedback to the groups as a whole.

d) Each observer pairs up with their observee to give individual feedback.

The whole process is then repeated with the two group's roles reversed.

APPENDIX 2 - Sample Lesson Materials

BBC Horizon Global Dimming -Viewing Handout

Watch the extracts, discuss questions in groups, take notes during second viewing to confirm answers.

A. How did climate scientist David Travis benefit from the tragedy of September 11th 2001? What did he observe? What are the implications of his observations? Is his evidence sufficient to establish those implications as scientific fact?

B. What did Gerald Stanhill measure in Israel? What was the practical purpose of his measurements at the time? What did he find when he returned 20 years later and repeated his measurements? What are the implications of his later measurements? How do they relate to Travis's observations after September 11th?

C. What results did Beate Liepert obtain independently in Germany? How did she and Stanhill check their results? What were the implications of their findings? How did the scientific community respond to them? What further research would you suggest might strengthen the case for global dimming?

D. What long-term data did Graham Farquhar and Michael Roderick consider? What trend did they notice? What was the 'apparent paradox'? How did they explain it? What was their extraordinary conclusion? How did they link it to the work of Stanhill and Liepert?

E. What are the causes of global dimming? [Veerabhadran Ramanathan's research in the Maldives]

F. What are the effects of global dimming? [Leon Rotstayn's remodelling of global climate based on the Maldives findings]

G. What solutions can you suggest to the problems caused by global dimming? [Ramanathan etc.]

H. What further problems might these solutions cause? [David Travis's post-September 11th glimpse of a world without global dimming]

Discussion

Compare the style of this documentary with academic styles of presenting information. Are you persuaded by the science presented or would you challenge it in any ways?

Discussion Moves Handout

Suggested moves you might make in academic discussion, with examples of appropriate language.

Establishing definition / clarifying understanding
Can we all first agree on what exactly X means?
Could you give us your definition of …?
Just to make sure that I'm following you, are you saying that …?
Sorry, I'm a bit unclear on that - could you expand a little?
Establishing agreement
That's a good point.
I agree with you there.
I think X put it very well when s/he said …
So let's just check, do we all agree that …?
Voicing disagreement
I can see the point you're making, but …
Perhaps you're right, but isn't it also true to say that …
Sorry, but I think you're missing the point here.
I agree with you to a certain extent, but don't we also need to consider ...?
Interrupting / bringing others into the discussion / changing the topic
Sorry to interrupt you, but I have a point which is relevant here.
OK, I can see what you're saying, can we just check what the rest of us feel about that?
Can I just interrupt and ask X what s/he thinks about this?
OK, this is all really good [look at watch], but shouldn't we be moving on now?
Resisting interruptions / changes of direction
No, please let me finish what I'm trying to say.
Yes, of course, but let me just finish my sentence!
OK, but can I quickly sum up my position before we move on?
I think we ought to find out what X thinks about this before we move on.
Moving from general to specific
Does anyone have a specific example of this …?
Can we think of a particular case in which this general rule might cause problems?
I can't quite imagine how that works in practice - can you describe a real situation?
I've just thought of an exception I think we might want to consider.
Moving from specific to general
That's an interesting case. What are its wider implications?
OK, that's a good example. Is it fairly typical, do you think?
You've told us about your experience. What in principle do you think it can tell us?
We've considered this situation. What general issues does it raise for us all?

Corporate Responsibility Discussion Task

Multinational oil and car manufacturing companies contribute significantly to the human activities which scientists now agree are responsible for global warming and other environmental threats.
1) Do you think these companies *should* be held responsible for their actions by people and governments throughout the world?
2) To what extent, in practice, do you think they *can* be held responsible?

Before you start your discussion, look at this list of concepts which might be relevant to these questions:

individuals	**corporations**	**governments**	**pressure groups**
corporate social responsibility		**moral obligation**	**legal duty**
short-term profits	**long-term consequences**		**social benefits**
producers	**consumers**	**shareholders**	**stakeholders**
codes of conduct	**national legislation**		**international agreements**
fines	**compensation payments**		**prison sentences**

Also, before you start, read the short texts on the reverse of this sheet.

(You are encouraged to make use of the information they contain, but try to incorporate it into your spoken contribution - don't read aloud from the texts.)

When you settle down in your group, compare your general ideas about the concepts and texts with the other group members, then move on to consider the two discussion questions in detail.

Finally, try to negotiate a consensus viewpoint in your group for each of the questions.

(Your consensus may include recognition of any disagreements or difficulties you had.)

Short texts sourced by Bristol University Pre-Sessional EAP students, 2006

http://www.strategiy.com/oilenergynew.asp?id=20050523133558

Corporate Social Responsibility Summit to be held in Dubai

Hussain Al Mahmoudi, External Affairs Manager at Shell, the event's main sponsor, said: "Corporates today have a more vital role to play in society, rather than merely concentrating on wealth creation. Their business goals intertwined with delivering benefits to people, communities and the environment. In other words, commercial success needs to be tempered with ethical values. CSR encompasses economic, environmental and social responsibilities, as these factors are the key drivers of sustainable development.

"By shifting the focus on CSR for all levels of enterprises, the CSR summit seeks to promote values associated with Corporate Social Responsibility, and show how an enterprise-wide policy can raise company profile as well as reflect on profits," added Mahmoudi. "Having practised CSR with concrete results, Shell would like to demonstrate how the benefits of CSR could percolate down to all levels of an organisation, conveying the message that no matter what the size of the company is, there is no substitute to ethical business practices."

http://www.mallenbaker.net/csr/CSRfiles/page.php?Story_ID=425

ExxonMobil launches global warming research programme

ExxonMobil is to launch a research programme worth up to $500m to help fight global warming. The move comes in the face of ongoing protests against the company by Greenpeace and other environmental campaigns. Exxon will announce the programme within the next few months and hopes to work with universities across the world to develop ways of producing, using and storing energy which will minimise the emission of carbon dioxide, methane and other greenhouse gases. Frank Sprow, ExxonMobil's vice president for safety, health and the environment, said he hoped other companies would contribute to the

programme. Meanwhile, Greenpeace and Friends of the Earth promoted a week of action against the company, arguing that Exxon has "spent millions of dollars sabotaging the Kyoto Protocol on climate

change". Protestors locked onto fuel pumps in Canada, activists in tiger suits led the Giro D'Italia bicycle race in Luxembourg and environmentalists circulated a critical report in New Zealand. Previously, ExxonMobil had fought back against its critics, labelling a report by a group of dissident investors claiming that its stance on global warming hurt shareholder value as "ridiculous".

http://www.environmentaldefense.org/pressrelease.cfm?ContentID=5310

Magnitude of Auto Emissions Implies a Shared Responsibility for Reductions

WASHINGTON – Cars and light trucks made by each of the Big Three automakers – GM, Ford, and DaimlerChrysler – emit more of the greenhouse gas carbon dioxide (CO_2) than the nation's largest electric utility, American Electric Power (AEP), with its nearly 60 large coal-fired power plants and 36,000 megawatts of generating capacity, according to a new report by Environmental Defense, *Global Warming on the Road.* The report provides a first-ever detailed breakdown of global warming pollution from all the automobiles in use on America's roads. According to the report, total U.S. auto sector CO_2 emissions for 2004 -- 314 million metric tons of carbon -- equaled the amount of carbon in a coal train 55,000 miles long, enough to circle the world twice. Emissions from GM's products were more than double those from AEP's power plants. Emissions from Toyota's products, ranked fourth among automakers, exceeded those from the Tennessee Valley Authority, the nation's third largest electric utility. "Fixing the global warming problem without making cars more efficient is like trying to fix a leaky roof without a hammer," said Environmental Defense President Fred Krupp. "The leading automakers must accept responsibility for becoming part of the solution."