IHPST NEWSLETTER, JUNE 2005

1. Eighth IHPST Conference, Leeds July 15-18

The conference is in final stages of preparation with the programme being structured and the Abstract book being printed. Currently there are 190 registrations, so it is expected that there will be around 200-220 participants.

The Conference Theme is:

Teaching and Communicating Science: What the History, Philosophy and Sociology of Science can Contribute

The conference is being held in conjunction with the British History of Science Society conference. Sessions of both conferences will be available to participants, and there will be some shared social events.

Plenary talks will be given by:

Professor Harry Collins: "The Uses of Sociology of Science for Scientists and Educators".

Dr Meera Nanda: "Making Science Sacred: How Postmodernism aids Religious Fundamentalism."

Professor Peter Bowler will present the Presidential Address at the BHSS conference, and this is scheduled as a joint session between the two conferences.

Approximately 160 papers (including 10 symposia) and 20 posters have been accepted from scholars from over 30 countries spanning every continent.

Accommodation can be had either at the university (about USD65 per night, or USD45 with shared facilities) or in local hotels. University accommodation inquiries and bookings can be made on the website. Hotel accommodation is secured directly with the hotels, whose contact details are listed on website.

Registration can be effected at the conference web site: www.ihpst2005.leeds.ac.uk or at the meeting. Cost is GBP145 (approx. USD265, EUR215).

2. Future IHPST Conferences

Pleasingly arrangements have already been made for the 9th (2007) and 10th (2009) IHPST conferences.

2007 Conference, late June, University of Calgary
Conference Chair: Professor Ian Winchester
Conference Secretary: Linda Lentz (email: Linda.Lentz@ucalgary.ca).

2009 Conference, June 24-28, University of Notre Dame,
Conference Chair: Professor Don Howard (email: dhoward1@ND.EDU).

Please schedule these meetings into future writing and travel plans, and bring them to the attention of related groups that might like to schedule meetings so as to enable participation at IHPST and their own conference.

3. "Science & Education", Vol.14, Nos.3-5,

A special triple issue (Vol.14, Nos.3-5, 290pp) of the journal 'Science & Education' will shortly be published It contains selected, reviewed and revised papers from the Seventh IHPST conference held in Winnipeg, 2003.

The contents follow.

SCIENCE & EDUCATION

Volume 14 Nos. 3,4,5 July 2005

SEVENTH INTERNATIONAL, HISTORY, PHILOSOPHY &
SCIENCE TEACHING CONFERENCE (WINNIPEG): SELECT CONTRIBUTIONS

Art Stinner & Don Metz (eds.)

ZOUBEIDA R. DAGHER & DANIELLE FORD / How are Scientists Portrayed in Children's Science Biographies?
GERALD SKOOG / The Coverage of Human Evolution in High School Biology Textbooks in the 20th Century and in Current State Science Standards
ERIC M. HOWE & DAVID W. RUDGE / Recapitulating the History of Sickle-Cell Anemia Research: Improving Students' NOS Views Explicitly and Reflectively
JEFF BABB / Mathematical Concepts and Proofs from Nicole Oresme: Using the History of Calculus to Teach Mathematics
DEBORAH L. BEGORAY & ARTHUR STINNER / Representing Science Through Historical Drama: *Lord Kelvin and the Age of the Earth Debate*
ROBERT CARSON & STUART ROWLANDS / Mechanics as the Logical Point of Entry for the Enculturation into Scientific Thinking

Journal subscriptions (USD80 pa, less for students and third-world scholars) can be effected at the IHPST web site www.ihpst.org.

4. History and Philosophy of Science in the USA Science Education Standards

The USA introduced national science education standards in 1996:

National Research Council: 1996, *National Science Education Standards*, National Academy Press, Washington.

It is noteworthy that these standards include knowledge and competence in the fields that members of the IHPST Group have been advocating and researching since its inception in 1989.

The Standards include the following statements:

> Students should develop an understanding of what science is, what science is not, what science can and cannot do, and how science contributes to culture. (p.21)
>
> The standards for the history and nature of science recommend the use of history in school science programs to clarify different aspects of scientific inquiry, the human aspects of science, and the role that science has played in the development of various cultures. (p.107)

The History and Nature of Science is listed in the K-4 section of the Standards:

> Students can learn some things about scientific inquiry and significant people from history, which will provide a foundation for the development of sophisticated ideas related to the history and nature of science that will be developed in later years. (p.141)

For Grades 5-8 it is stated that:

> Many individuals have contributed to the traditions of science. Studying some of these individuals provides further understanding of scientific inquiry, science as a human endeavour, the nature of science, and the relationships between science and society. (p.171)

> Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted. (p.171)

Much has already been written on these standards. See at least the following:

Collins, A.: 1998, 'National Science Education Standards: A Political Document', *Journal of Research in Science Teaching* **35**(7), 711-727.

McComas, W.F. & Olson, J.K.: 1998, 'The Nature of Science in International Science Education Standards Documents'. In W.F. McComas (ed.), *The Nature of Science in Science Education:Rationales and Strategies*, Kluwer Academic Publishers, Dordrecht, pp. 41-52.

There is wide agreement that the successful implementation of the HPS and NOS aspects of the standards will require the incorporation of some form of appropriate HPS courses into initial and continuing teacher education. Something that the IHPST has been advocating since its inception.

The different US states have incorporated the national standards in state standards.

The state standards are available at:

http://www.carolina.com/general/company/state_standards.asp

And also at:

http://edstandards.org/StSu/Science.html

A list of math standards by state is available at:

http://edstandards.org/StSu/Math.html

A link to state departments of education:

http://www.enc.org/professional/standards/state_de/

Frameworks for mathematics and science education provided by states can be found at:

http://www.enc.org/professional/standards/state

[The above links have kindly been provided by staff associated with the Notre Dame Summer Workshops on HPS and Science Teaching.]

5. Pendulum Anthology

Springer are publishing a 540 page anthology of 31 papers arising from the first research phase of the International Pendulum Project (IPP).

The IPP has been functioning since 2002 when the first pendulum research conference was held in Sydney. The IPP promotes scientific, historical and methodological studies of the pendulum, and supports enriched teaching of pendulum-related topics in school. Details can be seen at: www.arts.unsw.edu.au/pendulum/ .

Details of the anthology, and order information follow:

The Pendulum*: *Scientific, Historical, Philosophical & Educational Perspectives

Michael R. Matthews, Colin Gauld & Arthur Stinner (eds.),
Springer, Dordrecht, 2005

CONTENTS

MARIANNE BARNES, JAMES GARNER, DAVID REID / The Pendulum as Vehicle for Transitioning from Classical to Quantum Physics: History, Quantum Concepts and Educational Challenges
CATHY MARIOTTI EZRAILSON, G. DONALD ALLEN & CATHLEEN C. LOVING / Analyzing Dynamic Pendulum Motion in an Interactive Online Environment Using Flash
IGAL GALILI & DAVID SELA / Pendulum Activities in the Physics Curriculum: Used and Missed Opportunities
MANABU SUMIDA / The Public Understanding of Pendulum Motion: From 5 to 88 Years Old
PAUL ZACHOS / Pendulum Phenomena and the Assessment of Scientific Inquiry Capabilities
ERIN STAFFORD / What the Pendulum can Tell Educators about Children's Scientific Reasoning
MICHAEL FOWLER / Using Excel to Simulate Pendulum Motion and Maybe Understand Calculus a Little Better
RANDALL D. PETERS / Soup-Can Pendulum
DEMETRIS KOLIOPOULOS AND COSTAS CONSTANTINOU / An Analysis of the Treatment of the Simple Pendulum in Greek and Cypriot Science Curricula
ROBERT N. CARSON / Teaching Cultural History from Primary Events
COLIN GAULD / Pendulums in the Physics Education Literature: A Bibliography

The anthology can be ordered on-line at the IHPST website at: http://www.ihpst.org/ordering.html . Cost is USD35 (discounted IHPST group rate). The on-line form can also be printed and faxed or mailed.

6. Second International Pendulum Conference, Sydney, October 13-15, 2005

The Second International Pendulum Conference will be held at the University of New South Wales, Sydney, Australia from Wednesday evening October 13 to Saturday evening October 15, 2005.

There will be a 3-day research strand of the conference concurrent with a 2-day teachers meeting. Many of the contributors to the *Pendulum* anthology will be presenting and elaborating their research; additionally new research on scientific, historical, methodological, horological and pedagogical aspects of pendulum motion will be presented.

The concurrent teachers' meeting (Friday and Saturday) will involve Sydney primary and high school teachers who have been developing and trialing innovative pendulum-based lessons and programmes.

One presentation, by Don Metz of the University of Winnipeg, will describe a new pendulum-based 14-week senior science module being developed for the province of Manitoba in Canada.

Offers of papers for conference presentation are welcome. Below is a timetable for paper submission and conference registration.

August 1st Paper Title and 3-500 word abstact to be communicated to conference secretary. This should follow the format used in *Science & Education* journal.
September 19th Complete paper to be communicated, using *Science & Education* style and bibliographical format.
September 3rd Registration to be completed.

The registration fee of USD100 will cover conference dinner, a copy of the *Pendulum* anthology, morning and afternoon teas, etc.

Accommodation costs will vary from about USD60 to USD100 per night depending on style of accommodation chosen. Participants will be responsible for their own accommodation arrangements with the participating hotel and motel.

The main conference accommodation will be at the delightfully situated Crowne Plaza Hotel, Coogee Beach (http://www.ichotelsgroup.com/h/d/cp/1/en/hd/SYDCB?&) . Cost is approximately USD100 per night, with IPP/UNSW discount. Rooms should be booked as soon as possible. Other accommodation options are available from the conference secretary.

REGISTRATION FORM
SECOND INTERNATIONAL PENDULUM CONFERENCE.
OCTOBER 13-15, 2005

NAME (S):
UNIVERSITY / SCHOOL:
MAILING ADDRESS:

CONTACT PHONES:
EMAIL:

☐ I WILL ATTEND THE CONFERENCE (USD100 / AUD130 - gst inclusive)

☐ I AM UNABLE TO ATTEND THE CONFERENCE, PLEASE MAIL THE *PENDLUM* anthology (USD35 / AUD45)

☐ PLEASE MAIL PRE-CONFERENCE BOOK, *TIME FOR SCIENCE EDUCATION* (USD25 / AUD35)

FIND ENCLOSED CHEQUE FOR $_____(cheques to 'International Pendulum Project')

OR, CHARGE MY CREDIT CARD :

NAME:
NUMBER:
EXPIRY DATE:

return as early as possible, and no later than September 3rd, to:
A/Prof. Michael R. Matthews, School of Education, UNSW, Sydney 2052
email: m.matthews@unsw.edu.au

7. HPS and Science Teaching Web Sites

The following web sites have been provided by Robert Hatch of the University of Florida, Gainesville. For a number of years he conducted NSF-sponsored courses on history of science for both US history teachers and science teachers.

Readers are invited to send their own collections of tested web sites to the newsletter editor for future publication.

American Historical Association web: www.historians.org	**H-High-S** **(for high school history teachers)** web: h-net2.msu.edu/~highs
H-Teach **(for college and university history teachers)** web: h-net2.msu.edu/~teach	**The History Cooperative** web: www.historycooperative.org
History Teaching Alliance web: hss.cmu.edu/nhen	**National Center for History in the Schools (NCHS)** e-mail: gnash@ucla.edu
National Council for History Education (NCHE) web: www.history.org/nche e-mail: nche19@mail.idt.net	**National Council for the Social Studies (NCSS)** e-mail: ncss@ncss.org
National History Day (NHD) web: www.thehistorynet.com/NationalHistoryDay e-mail: hstrydayaol.com	**Organization of American Historians (OAH)** web: www.oah.org
World History Association (WHA) web: www.woodrow.org/teachers/world-history	

NSF - Lesson Plans - Secondary & Middle Schools
Lesson Plans - Darwin & Evolution -
History of Science Study Guide -
History of Science Reference Sources
Journals: History of Sci-Tech-Med
SHiPS: Science Teachers Network
History of Science WebLinks
History & His-Sci: Search the Web

Lesson Plans - History & Science

Teacher Lesson Plans - Share
Lesson Plans - Education Helper
Classroom Learning - Lesson Plans
Teach-Net - Lesson Plans

For Teachers of Science

National Science Teaching Home Page
WebSite Search: Science Education

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8. Third Hellenic History, Philosophy and Science Teaching Conference, 19-25 September 2005

The 3rd Hellenic Conference on "History, Philosophy and Science Teaching" will be held in Athens 19-25 September 2005. The event is planned to take place in conjunction with the European Physical Society Conference "Notions of Physics in Natural Philosophy" which will be held between 23-25 Sept. 2005 ie. in the last 3 days of the Hellenic HPST Conference.

The Athens EPS Conference is part of a series of events organized by EPS to commemorate the 100th anniversary from the publication of Einstein's famous paper on Relativity (2005 is the World Year of Physics).

The language of the HPST Conference is Greek while the language of the EPS Conference is English and French to encourage and facilitate the participation of scholars from around Europe and the rest of the world. Both events are endorsed by the Hellenic Physical Society.

The Conference Website is: http://asel.primedu.uoa.gr/synedrio/sinedrio_index_en.htm

For any information please contact the Conference Organisers:

- A/Prof. Constantine D. Skordoulis (kskordul@primedu.uoa.gr)
  Department of Education, University of Athens
- Prof. Efthymios Nicolaidis (efnicol@eie.gr)
  History & Philosophy of Science Program, National Hellenic Research Foundation.

9. Current Research

Apart from contributions to *Science & Education* the following are some papers published in recent years that bear upon the research concerns of the IHPST Group. Suggestions for up-dating this list should be sent to the Editor at m.matthews@unsw.edu.au

Aalsvoort, J.v.: 2004, 'Logical Positivism as a Tool to Analyse the Problem of Chemistry's Lack of Relevance in Secondary School Chemical Education', *International Journal of Science Education* **26** (9), 1151-1168.

Abd-El-Khalick, F. & Akerson, V.L.: 2004, 'Learning as Conceptual Change: Factors Mediating the Development of Preservice Elementary Teachers' Views of the Nature of Science', *Science Education* **88**(5), 785-810.

Allchin, D.: 2004, 'Should the Sociology of Science Be Rated X?', *Science Education* **88**(6), 934-946.
Bartholomew, H., Osborne, J. & Ratcliffe, M.: 2004, 'Teaching students "ideas about science": Five dimensions of effective practice', *Science Education* **88** (5), 655-682.
Donnelly, J.F.: 2004, 'Humanizing Science Education', *Science Education* **88**(5), 762-784.
Duschl, R.A.: 2004, 'Relating History of Science to Learning and Teaching Science: Using and Abusing'. In L.B. Flick & N.G. Lederman (eds) *Scientific Inquiry and Nature of Science: Implications for Teaching, Learning, and Teacher Education*, Kluwer Academic Publishers, Dordrecht, pp.319-330.
Matthews, M.R.: 2004, 'Thomas Kuhn's Impact on Science Education: What Lessons can be Learnt?', *Science Education* **88**(1), 90-118.
Niaz, M., Rodríguez, M.A. & Brito, A.: 2004, 'An appraisal of Mendeleev's contribution to the development of the periodic table', *Studies in History and Philosophy of Science* **35A**, 271-282.
Niaz, M.: 2004, 'Did Columbus *hypothesize* or *predict* that if he sailed due West, he would arrive at the Indies?', *Journal of Genetic Psychology* **165**, 149-156.
Rodríguez, M.A. & Niaz, M.: 2004, 'A reconstruction of structure of the atom and its implications for general physics textbooks: A history and philosophy of science perspective', *Journal of Science Education and Technology* **13**, 409-424.
Rodríguez, M.A. & Niaz, M.: 2004, 'The oil drop experiment: An illustration of scientific research methodology and its implications for physics textbooks', *Instructional Science* **32**, 357-386.
Sandoval, W. A. & Reiser, B. J.: 2004, 'Explanation-driven Inquiry: Integrating conceptual and epistemic scaffolds for Scientific inquiry', *Science Education*, **88** (3), 345-372.
Schwartz, R.S., Lederman, N.G., Crawford, B.: 2004, 'Developing views of the nature of science in an authentic context: An explicit approach to bridging the gap between nature of science and scientific inquiry', *Science Education*, **88** (4), 610-645.
Siegel, H.: 2004, 'The Bearing of Philosophy of Science on Science Education, and Vice Versa: The Case of Constructivism', *Studies in History and Philosophy of Science*, **35A**, 185-198.
Symington, D. & Tytler, R.: 2004, 'Community Leaders' Views of the Purposes of Science in the Compulsory Years of Schooling', *International Journal of Science Education* **26**(11), 1403-1418.
Westerlund, J. & Fairbanks, D.: 2004, 'Gregor Mendel and "Myth-Conceptions"', *Science Education* **88**(5), 754-758.
Wickman, P.-O.: 2004, 'The practical Epistemologies of the classroom: A study of laboratory work' *Science Education*, **88** (3), 325-344.

10. Coming Conferences

July 7-8, 2005. British Society for the Philosophy of Science annual conference, University of Manchester.
July 15-18, 2005. IHPST, International History, Philosophy and Science Teaching Group conference, Leeds, England. Details at www.ihpst.org
September 19-25, 2005. Third Hellenic HPS & ST conference. Details at: : http://asel.primedu.uoa.gr/synedrio/sinedrio_index_en.htm
October 13-15, 2005 2nd International Pendulum Conference, Sydney. Details at: www.arts.unsw.edu.au/pendulum/
March 26-30, 2006. Symposium on "Science History and Its Applications to Chemical Education", as part of American Chemical Society meeting in Atlanta, GA. Details from: Seth C. Rasmussen, seth.rasmussen@ndsu.edu.
April 3-6, 2006, NARST conference, San Francisco. Details at: http://www.educ.sfu.ca/narstsite/
April 8-12, AERA conference, San Francisco
April 21-24, PES conference, Puerto Vallarta, Mexico. Details at: http://cuip.net/pes/

11. Publications for Sale

The following publications are available from the IHPST Group:

#1 *CD Proceedings of the 6th IHPST Conference, Denver, 2001,* 100+ papers, W. McComas (ed.), USD10 (postage included).
#2 *CD Proceedings of the 7th IHPST Conference, Winnipeg, 2003,* 100+ papers, D. Metz (ed.), USD10 (postage included).
#3 *Time for Science Education*, M.R. Matthews, Kluwer, 2000, 440pp, USD20 (postage included).
#4 *Science Education and Culture*, F. Bevilacqua, E. Giannetto & M.R. Matthews (eds.), Kluwer, 2001, 362pp, USD20 (postage included).
#5 *Challenging New Zealand Science Education*, M.R. Matthews, Dunmore Press, 1995, 256pp, USD10 (postage included).
#6 *Science & Education* journal Volume 12, 2003, 808 pps, USD25 (postage included).
#7 *Science & Education* journal Volume 2, 1993, 382pp, USD10 (postage included).

To purchase any of the above, send letter or email, with complete mailing address and indication of what publications are required, to address below. Cheques payable to 'IHPST', or send full credit card details (visa, or mastercard). Alternatively order from IHPST web site: www.ihpst.org

12. Book Notes

(1) Lisa Jardine, *The Curious Life of Robert Hooke*: *The Man Who Measured London*, Harper Collins, New York, 2003. ISBN 0 00 714944 1, 422 pps.

Lisa Jardine is the daughter of Jacob Bronowski (as she has occasion to tell in the first chapter of this book). She is also Professor of Renaissance Studies at the University of London, and the author of a number of popular books on intellectual and scientific history. Among the latter is *Ingenious Pursuits: Building the Scientific Revolution* (Little Brown, 1999).

Hooke (1635-1703) is seen as one of the lesser figures of the Scientific Revolution. He is known to science students largely due to the law of deformation that bears his name (*for an elastic deformation, stress is proportional to strain*). There is just one 'Hooke's Law', and it is not a major one. There is nothing else in science that bears his name. But nevertheless, as an early study recounts: 'Hooke was one of the outstanding figures of his age. His mind ranged over the entire scientific studies of his time, and there was hardly any branch of science which he did not consider, and to whose advancement he did not contribute' (R.T. Gould, *The Marine Chronometer*, 1923, p. 24).

He was, for instance, the author of one of the earliest books on microscopy – *Micrographia* (1665), and the author of the earliest systematic work on springs and deformation – *De Potentia Restitutiva or of Spring* (1678). Hooke was the first to state clearly that the motion of heavenly bodies must be regarded as a mechanical problem not one of self-movers. He approached in a remarkable manner Newton's discovery of the inverse square law of universal gravitation, and indeed claimed credit for Newton's discovery. Likewise he claimed credit for Huygens' creation of the pendulum clock. He made a similar claim against Boyle for the law of gaseous compression that bears the latter's name. Hooke was so often the bridesmaid, but constantly claimed to be the bride.

In addition he was an architect of some consequence, who worked with his cousin Christopher Wren on many projects after the 1666 Great Fire of London. He was a member of the small group of Oxford and London 'philosophers' that met informally at Gresham College (others included Wren and Boyle) which would become in 1661 the Royal Society. Hooke was elected a

Fellow of the Society in 1663, and held the position of Curator of Experiments for the duration of his life.

Jardine writes in the first chapter that: 'He lies the challenge for anyone who embarks on writing a life of Robert Hooke. How does one convey the genius of a man whose versatility condemned him, in each field of his interest, to miss the mark by a whisker – the man who, in the helter-skelter race to make the fundamental discoveries of modern science and technology, always took second place?' (p.3).

With ten pages of colour plates, numerous black-and-white prints, the use of 300-odd references, and a fine writing style – Jardine more than meets the challenge faced by biographers of Hooke.

(2) Hakkarainen, K., Palonen, T., Paavola, S. & Lehtinen, E.: 2004, *Communities of Networked Expertise: Professional and Educational Perspectives,* Elsevier, Amsterdam.

The focus of the book is on analyzing the socio-cognitive foundations of human intelligent activity. The authors examine theories and models that help to understand individual and social aspects of processes of learning, development of expertise, knowledge creation, and innovation. These processes are studied both in the contexts of education and work, and are illuminated with numerous examples, and interview data. The main topics covered are the development of expertise, distributed cognition and shared expertise, collaborative and cultural learning, and inquiry-based and computer-supported learning processes.

13. Book Review

Peter J. Fensham *Defining an Identity: The Evolution of Science Education as a Field of Research*, Kluwer Academic Publishers, Dordrecht, 2004. ISBN 1-4020-1467-8

Peter Fensham was, in 1967, appointed to the first professorship of science education in Australia; he has for long been a prominent figure in international science education with his contribution being recognized in a recent anthology (Cross 2003). His book *Defining an Identity* 'gives graduate students and other early researchers an unusual overview of their research area as a whole' (rear cover). It is built around interviews with 79 leading science educators from 16 countries with 48 being from the USA, Canada, Australia and England. The interviewees include at least 16 past Presidents of the National Association for Research in Science Teaching (NARST), and 10-15 current or past editors of the three major international science education research journals. In total, the interviewees have authored scores of books and probably the between one and two thousand research articles. Given Fensham's status and the 'Who's Who' roll-call of researchers interviewed, the book is a wonderful and timely source for ascertaining the current state of science education research: its concerns, its theoretical assumptions, its achievements, and the usefulness of its pedagogical recommendations.

The interviewees were asked to respond to two questions:

 # Tell me about two of your publications in the field that you regard as significant.

 # Tell me about up to three publications by others that have had a major influence on your research work in the field.

The publications mentioned in both answers are listed in the book's appendicies along with the participant's names. The interview transcripts are used to answer three questions about 'the emergence of science education as an international field of research' (p.xi). Fensham wants to

know about: (1) its identity as a research field; (2) the researcher as a person; (3) trends in the research.

Having identified these purposes he sets out 14 criteria as hallmarks of a research field – six structural, seven intra-research, and one concerned with outcomes or applications (p.8). Fensham in fifteen chapters discusses the interviewees' major publications and the publications they nominate as influencing them in terms of these criteria.

PERSONAL ASPECT

The book has a very personal tone. This tone is set in the Introduction where, unexpectedly, the personal pronoun occurs 50 times in the first seven pages. Although unusual, there is something theoretical driving this personalist orientation. This is indicated when Fensham approvingly quotes the claim of John Mason that: 'the most significant products of research in mathematical education are the transformations in the being of the researcher' (p.37). Fensham says the same applies to science education research; and indicates that Mason's concern 'stems from his interest in Heidegger's (1927) notion of *Being-in-the-world*'.

The conviction that the most significant product of science education research is the 'transformation in the being of the researchers' is arresting, to say the least. Outsiders, including research funding agencies, might reasonably expect the most significant products of such research to be a better knowledge of how children learn science, or how teachers can best teach science, or what curriculum is most appropriate for different groups. Transformation in the being of researchers is reasonably thought of as a by-product of research, not the purpose of the research.

THE PREPARATION OF SCIENCE EDUCATION RESEARCHERS

The interviews do reveal a significant problem with 'The evolution of science education as a field of research': namely researchers in the field are woefully under prepared for conducting their research. Fensham remarks on many occasions that the pioneer researchers came into the field either from a research position in the sciences or from senior positions in school teaching. For both paths, training in psychology, sociology, history or philosophy was exceptional. He mentions Joseph Schwab, 'a biologist with philosophical background' as an exception (p.20). He could have mentioned F.W. Westaway in the UK and Walter Jung in Germany, but not many others could have been named as exceptions to the general rule.

This failure of preparation did not changed for second generation or younger researchers. Indeed it has perhaps got worse, as proportionally fewer science education researchers have the experience of scientific research that the founders of the discipline had. The interviews reveal that the overwhelming educational pattern for current researchers is: undergraduate science degree, school teaching, then a doctoral degree in science education. As Fensham remarks 'Most researchers in science education have been teachers in schools, usually secondary ones, before their academic appointments' (p.164). Most have no rigorous undergraduate training in psychology, sociology, history or philosophy. At best 'As part of their preparation for the development tasks, these teachers had opportunities to read and reflect on materials for science teaching in schools and education systems that were different from their own limited experience of science teaching' (p.22). But there is usually a difference in outcome between 'reading and reflecting' on the one hand and the deliberate and systematic introduction to a discipline on the other hand. In the latter, lecture courses are attended, essays are written and corrected by experts, and examinations prepared for and sat. The lack of discipline preparation impacts greatly on the quality of work done in the field. Shallow philosophy, psychology, sociology and politics are commonplace.

SHALLOW PHILOSOPHY

Fensham's book well documents the impact of relativist and idealist philosophy on science education research.

Von Glasersfeld's Influence

A number of interviewees cite Ernst von Glasersfeld as 'a most significant influence'. Fensham states that 'von Glasersfeld's many writings on personal constructivism have had a very widespread influence on researchers in science education …. In their published research he is regularly cited as a general source for constructivist learning' (p.5).

That von Glasersfeld has had this influence is undoubtedly true. One prominent interviewee, and enthusiast for von Glasersfeld's constructivism, has written that: 'according to radical constructivism, we live forever in our own, self-constructed worlds; the world cannot ever be described apart from our frames of experience. This understanding is consistent with the view that there are as many worlds as there are knowers' (Roth 1995, p.13). The same researcher goes on to state that 'Radical constructivism forces us to abandon the traditional distinction between knowledge and beliefs. This distinction only makes sense within an objective-realist view of the world …' (p.14). And good measure he adds that 'Through this research [sociology of science], we have come to realize that scientific rationality and special problem solving skills are parts of a myth' (p.31).

This philosophical idealism is very heady stuff, and the researcher has won numerous awards for writing it, but is it correct? The answer is No, and further the views are simply inconsistent with the ontological and epistemological requirements of science.

Von Glasersfeld acknowledges having no training in philosophy, and describes himself as an amateur in the field (Glasersfeld 1995, p.4). His philosophical position is simply Bishop Berkeley's empiricism, with some Piagetian additives. Science education researchers may not have been so influenced by von Glasersfeld's constructivist restatement of Bishop Berkeley if they had done an undergraduate philosophy programme where Berkeley's empiricism is historically situated and his theory of perception, his account of mental imagery, his theory of knowledge and his critiques of Newtonian science are all routinely criticised.

Wallis Suchting exposed a host of philosophical problems with von Glasersfeld's position, and in a lengthy critique concluded that:

> First, much of the doctrine known as 'constructivism' ... is simply unintelligible. Second, to the extent that it is intelligible ... it is simply confused. Third, there is a complete absence of any argument for whatever positions can be made out. ... In general, far from being what it is claimed to be, namely, the New Age in philosophy of science, an even slightly perceptive ear can detect the familiar voice of a really quite primitive, traditional subjectivistic empiricism with some overtones of diverse provenance like Piaget and Kuhn. (Suchting 1992, p. 247)

But Suchting's arguments have not been attended to by science educators, and his name does not even appear in the Name Index of von Glasersfeld's 1995 book *Radical Constructivism*. There is a bizarre irony in the fact that contemporary science educators flock to the banner of a latter-day Berkeley when the original Berkeley was Isaac Newton's fiercest critic.

Thomas Kuhn's Influence

The other philosopher mentioned by some of Fensham's interviewees as having a major influence on them was Thomas Kuhn. But as with von Glasersfeld, the science education community took up Kuhn's ideas in an altogether uncritical way; 'the community became a cheer-squad for Kuhn' is how Loving and Cobern summarised Kuhn's impact (Loving & Cobern 2000).

Kuhn is more cited than read; the mere citation of Kuhn is considered to constitute an argument or to provide evidence for some philosophical view. One interviewee in a publication writes that: 'In recent years, the rational foundations of Western science and the self-perpetuating belief in the scientific method have come into question …. The notion of finding a truth for reality is highly questionable' (Fleer 1999, p.119). No evidence is adduced for this sweeping claim except an unpaginated reference to Kuhn. This practice of having a Kuhn citation substitute for evidence or argument is widespread.

The extensive philosophical critiques of Kuhn's notions of paradigm, incommensurability, theory dependence of observation, intra-theoretic rationality, and so on, have gone largely unnoticed (Matthews 2004). One sympathetic appraisal of Kuhn correctly maintains that: 'Kuhn's treatment of philosophical ideas is neither systematic nor rigorous. He rarely engaged in the stock-in-trade of modern philosophers, the careful and precise analysis of the details of other philosopher's views, and when he did so the results were not encouraging' (Bird 2000, p.ix).

Abner Shimony, a physicist and philosopher, said of the key Kuhnian move of deriving methodological lessons from scientific practice that: 'His work deserves censure on this point whatever the answer might turn out to be, just because it treats central problems of methodology elliptically, ambiguously, and without the attention to details that is essential for controlled analysis' (Shimony 1976, p.582).

Kuhn admits that he is an interloper to philosophy, having never taken a course in the subject; and he candidly confesses that his treatment of philosophical issues in his famous *Structure of Scientific Revolutions* was 'irresponsible' (Conant & Haugeland 2000, p.305). In reviewing his achievements, he regretted the 'purple passages' he wrote in *Structures*. Unfortunately it was often the purple passages that were seized on by so many in the science education community. By the time Kuhn regretted them and tried to close the stable door, they had bolted out into countless research fields including science education.

The Edinburgh Influence

Another indicator of inadequate philosophical training is the extent to which the claims of the Edinburgh 'Strong Programme in the Sociology of Scientific Knowledge' (SSK) are uncritically endorsed. Fensham reports that: 'One book stood out as an influence about the culture of science and that was Latour and Woolgar's *Laboratory Life*' (p.58).

This book is at the extreme, idealist, wing of the SSK movement. It is an attempt at an anthropological study of laboratory research on THR (thyrotropin releasing hormone) where one author, Latour, thought it advantageous that he knew absolutely no science. The book argues that all science is 'the construction of fictions', and that scientific success is simply the ability of one group, in this case the Nobel Prize winners Schally and Guillemin, to 'extract compliance' from another. They make the outright idealist claim that THR exists only if a certain bioassay procedure is accepted.

However this claim is peculiar. The bioassay result might be grounds for *believing* in THR, but hardly grounds for THR existing. But adherents of the SSK programme make the same claim about even massive bodies such as planets, which supposedly only come into existence when

discovered. This is idealism in its purest form: the world is dependent upon our mind. What intellectual nourishment science educators can find in such an anti-scientific doctrine is difficult to imagine.

Latour, Woolgar and those more deeply affected by them, believe that the efforts of Galileo, Newton, Darwin, Einstein, and the roll-call of contributors to the scientific tradition, have not revealed truths about the world, but have revealed how to succeed in science, and this success owes nothing to any fit between scientific claims and the world. That *Laboratory Life*, whose arguments have been soundly criticised by historians and philosophers, should be so often nominated as an 'important influence' by Fensham's 80 key international science educators is truly disturbing, and another example of what can go wrong with a research field when the basics are missing.

The philosophical critiques of von Glasersfeld, Kuhn and the Edinburgh programme have gone largely unnoticed, in part because the training of science education researchers does not put them into contact with these critiques. Such training might inoculate researchers against what David Stove generously called 'philosophical folly'.

It is revealing how one influential interviewee did respond to a philosophical critique of constructivist writing:

> Too often the critiques were based on analyses of the use of single words and sentences from one text … word-by-word and line-by-line analyses were not convincing when the [constructivist] authors regarded the meaning as constituted in entire texts or collections of texts. (Tobin 2000, p.242)

Since Plato philosophers routinely ask 'What do you mean by?', 'Is the meaning here the same as the meaning there?', 'What consequences flow from this interpretation?', and so on. David Hume called it the 'slow, lingering method'. The above researcher objects to what philosophers do; but to say that meaning need not be specified in words, sentences, paragraphs, or even in whole books is surely to invite meaningless writing. There is enough of this even when authors try to avoid it, but to say that one should not even try to write consistently meaningful sentences and paragraphs, is to open the floodgates to nonsense.

CHILDREN'S IDEAS

The extent to which the heady mix of Kuhnian and Strong Programme relativism has gotten a grip on science education research is revealed when Fensham himself, discussing alternative conception research, says: 'The continued use by some researchers particularly in the USA of the term *misconceptions* for the findings of alternative conceptions research in science education encourages a response to them that merely looks for cognitive change pedagogies' (p.153). Fensham thinks it wrong for teachers and researchers to judge children's ideas as wrong, as misconceptions. He prefers the non-judgemental 'alternative conception' label.

Consistent with this theme, two interviewees write that:

> It is inappropriate for classroom interactions to convey the impression that there is a single correct explanation of any phenomena or a single definition of any concept. (Carr et al. 1994, p.156)

Such advice seems to deliberately reject the distinction between correct and incorrect explanations, a distinction which is at the heart of science and at the centre of scientific inquiry. The fall of mercury in a barometer with increase in altitude is correctly explained by decrease in air pressure, it is not explained by decrease in gravitational attraction or by nature abhorring a vacuum. And there are correct and incorrect definitions of theoretical terms in science – 'speed' and

'velocity' have different and specific meanings – children who fail to get the correct definition just flounder. Likewise there is a correct definition of acceleration and without a proper understanding of it, a student cannot manipulate notions of force in classical mechanics. Science is more structured, defined and rule governed than the above researchers are suggesting.

Fensham's preference for 'alternative conceptions' rather than 'misconceptions' might be harmlessly thought of as just pedagogically strategic, but not so. Fensham is against the 'unquestioned' science content of the curriculum or textbook, saying that: 'When it is accepted that the science content itself can be problematic, the research approach to alternative conceptions can, however, take several other forms (p.154). His position is not that the choice of science content for a curriculum is problematic – it assuredly is – but rather the science itself is problematic. This is a very different claim, and if held to, it certainly does lead research in other directions apart from the well-trod path of trying to find out how kids might best learn science.

One interviewee has written that:

> Fensham's comments, made in a keynote address at the biennial meeting of the European Science Education Research Association in Kiel in 1999 … offered a challenge for researchers who are willing to consider science content as being problematic rather than simply an issue in school science. (Treagust 2003, p.201).

QUEER SCIENCE

Fensham thinks that the challenge to think of science content as problematic is so important that he repeats it on the rear cover of the book, where he makes 'a plea for the science content itself to be seen as problematic'. This opens up all sorts of new research areas and directions.

One example is queer science. Recently in the *Journal of Research in Science Teaching* two researchers claimed that: 'Using the lens of queer theory, we can view the hegemonic matrix, interrupt heteronormative thinking, and broaden all students' potential for interpreting, representing, and perceiving experiences' (Snyder & Broadway 2004, p.621). They maintain that Queer theory 'is both ontological and epistemological as it questions knowing and the nature of being' (Snyder & Broadway 2004, p.619).

The researchers further claim that: 'Language limits our ability to see truths of nature thus the search for truths should be abandoned for the search of understanding the descriptors that shape our lives' (Snyder & Broadway 2004, p.620). One is tempted to ask that if language limits our ability to see truths, will descriptors (whatever they might be) be any better? On the face of it, this the claim means abandoning science and solely pursuing hermeneutical studies. Indeed, the authors do endorse just such a position when later they write: 'Truth of nature, then, becomes cultural interpretations of meaning' (p.623).

This truly revolutionary position can be seen as an instance of researchers taking up Fensham's challenge to 'problematise the content of science', however it is simply inconsistent with the pursuit of orthodox science education. Hermeneutics is a necessary part of science education, students assuredly must understand the meanings of technical words and theoretical concepts (assuming that they have a meaning!), but science education also depends on words having *reference* in nature not just meaning. The whole enterprise of developing better technology to explore the micro-world and the astronomical-world is predicated upon the assumption that there is a possible reference for scientific terms (microbe, bacteria, asteroid, embolism, planet, black holes, ion, etc.) and that careful observation and experimentation is germane to determining whether there is such a referent and what its properties are. It is a hermeneutical task to ascertain the *meaning* of

'Santa Claus', it is a *scientific task* to see if the term has reference. The above authors do not seem to appreciate the difference.

SHALLOW PSYCHOLOGY

Lack of rigorous preparation for science education research is also evidenced by the extent of shallow learning theory in the field. Fensham recognises this and says that 'science educators borrow psychological theories of learning … for example Bruner, Gagne and Piaget' (p.105). And he goes on to say, damningly, that 'The influence of these borrowings is better described as the lifting of slogan-like ideas from these theories' (p.105).

It is the lack of thorough training in undergraduate psychology that leaves researchers dependent upon a sloganistic interpretation of theory. Three or four years hard slog in learning a discipline usually liberates students from dependence on slogans but, as Fensham so clearly attests, few in the science education research community have undergone this hard slog in the foundation disciplines.

One prominent interviewee speaks for many, when he says:

> When I began teaching more than a decade ago, I had just completed a masters degree in physics, but I did not have any background in educational psychology or methodology.' (Roth 1993, p.145

Bruner lamented educators' sloganistic interpretations of his idea of discovery learning (Bruner 1974). More recently the same fate befell the much-cited Posner et al. 1982 article on 'Accommodation of a Scientific Conception : Toward a Theory of Conceptual Change' (Posner et al. 1982). Ten years after its publication two of the co-authors, Posner and Strike, were moved to publish 'A Revisionist Theory of Conceptual Change' (Strike & Posner 1992) where they pointed out that the original paper was intended to be an account of just *rational* conceptual change, and that it was not meant to be taken as a template for teaching.

Both points were frequently overlooked in the science education community: The former, perhaps in part, because some of the more constructivist elements of the community simply deny the very possibility of *rational* conceptual change.

The same shallowness is evident in the field's rush to various 'social learning' theories. Fensham says of this that 'there was a further borrowing of the theoretical ideas of situated cognition that had burst on the educational research scene ..' (p.139). One prominent interviewee, and winner of many awards, says of Jean Lave's book *Cognition in Practice* that it has 'done most in terms of theoretical advance. She shows quite lucidly what it means for cognition to be situated and she gives examples' (p.80).

Why the work of Lave and her colleague Wegner is so admired by science educators is a mystery. Lave says that schools are: 'terrible places' that foster the 'alienation of knowledgeable skill from the construction of identity' and that they 'decompose activity to the point of meaninglessness' (Lave 1991, p.78). Such views are hardly designed to build rapport between science educators and school teachers.

Further, the theory of situated cognition, such as there is any, has problems. The first is trying to separate situated from non-situated cognition. All cognition depends on universals: 'the bird is red', 'two bananas and two bananas add up to four bananas', 'billy is a boy', and so on. The statements might be made in a situation (however this applies to all statements), but they have a

universal dimension. When experience is articulated, language is used; and language This is just what concepts are. So separating 'situated' from 'decontextual' statements is problematic.

But worse, the whole enterprise of science is a move from what might be thought of as situated claims to decontextual ones: from falling autumn leafs, falling stones, falling balls to just falling objects (including rotating planets!). The essence of science is abstraction: If decontextual 'discourse' is bad, then science is bad.

MISGUIDED PEDAGOGY

But apart from theoretical problems, the pedagogical recommendations of prominent situated cognition researchers are dubious. Lave at one point says that a consequence of her theory for mathematics learning is that we should be 'engaging children in early phases of an apprenticeship to mathematical masters, so that they learn how to do what mathematicians do, or at least, experience a way in how they do it' (Lave 1993, p.86). Another situated cognitionist recommends children 'sit on the fringe of a community of mathematicians to get a sense of the enterprise ... and learn its language' (Schonfeld 1992). These astonishing pedagogical claims have been well criticised by Mordechai Ben-Ari in a forthcoming article (Ben-Ari 2005).

Apart from the obvious practical difficulties - how many 100s of children will be apprenticed to any one of the few mathematical masters, or what kind of stadium would be required for whole schools to sit on the fringe of a community of mathematicians - children just cannot learn mathematics this way. How to do long division, how to factor an equation, how to derive a second derivative, how to integrate a function – is not learnt by osmosis. The competencies are not developed by the 'experience of watching others', but by careful guidance, explanation and repeated practice.

This commonsense point has been demonstrated again and again; most recently by Richard Mayer in his review of four decades of research on variants of discovery learning (Mayer 2004). Mayer argues that 'there is sufficient research evidence to make any reasonable person sceptical about the benefits of discovery learning – practiced under the guise of cognitive constructivism or social constructivism – as a preferred instructional method' (Mayer 2004, p.14). For science educators to champion the pedagogical recommendations of Lave, Schonfeld and others is irresponsible, to put it mildly.

Children could sit on the fringe of a scientific community for as long as they like and never learn the difference between vector and scalar quantities unless someone in the community took time off to carefully explain the difference to them – in other words to teach them. And until children understand the difference scalar and vector quantities, they will not understand the laws of motion.

This point is the same for all of science; there are basic concepts that first need to be learnt and understood before one can participate in the enterprise, or even understand the enterprise. No wonder parents around the world are throwing their hands up in despair when their children are inflicted with 'modern, research-inspired, teaching regimes'.

THE SOCIO-POLITICAL CONTEXT OF SCIENCE EDUCATION

Even competent psychology can still be intellectually shallow, and educationally useless, if it is divorced from an appreciation of the social, economic and political situation in which school science learning, teaching and curriculum development occurs. The Marxist tradition has long recognised this, and has taken its cue from the *1844 Paris Manuscripts* where Marx writes that a

psychology that neglects these external dimensions of life 'cannot become a genuine, comprehensive and *real* science'.

In a penultimate chapter on 'Politics and Science Education' Fensham recognises the force of this critique saying that science education research 'assumes a political vacuum condition', and he goes on to say that 'The dominance of psychological views of teaching and learning and of reductionist frameworks for so many of the research designs are no doubt largely responsible' (p.187). The result is that most studies of teaching and learning do not 'do justice to the school-based, and wider educo-political constraints under which these processes occur' (p.187).

Once more Fensham is correct in this observation. The identification of science education with studies of children's learning has rendered many in the profession blind to the socio-political context in which learning takes place. This is surprising as any decent learning theory is going to recognize the place of motivation in learning, and once motivation is recognized then the way should be pointed to the wider socio, economic and political sphere. There are many useful things that could be brought to light if the larger context of science education were studied, but this requires historical, economic and sociological competence which is rare in the field. The historical work of William Brock, David Layton and Edgar Jenkins in the UK, and George DeBoer and John Rudolph in the US are noteworthy contributions to this otherwise sparse landscape.

Psychology dominates science education research in large measure because the practitioners have no alternative: training in history, sociology or philosophy. Jay Lemke, mentioned by Fensham as a pioneering researcher on the effect of language in science learning (p.201), well recognises this when he writes:

> Science education researchers are not often enough formally trained in the disciplines from which socio-cultural perspectives and research methods derive. Most of us are self-taught or have learned these matters second-hand from others who are also not fully trained. (Lemke 2001, p.303).

Depressingly, this is a situation where the bland lead the blind.

THE IMPACT OF CRITICAL THEORY ON SCIENCE EDUCATION RESEARCH

Alarmingly, when some science educators do begin to take a wider view of their subject they turn to Critical Theory. A recent article in *The Journal of Research in Science Teaching* opines that critical theory is a 'guide for emancipating human thought and actions' (Synder & Broadway 2004, p.619). Increasingly in the field one finds reference to critical theorists such as Henry Giroux, Peter MacLean, Stanley Aronowitz and Michael Apple.

There is argument about what Critical Theory can emancipate, but there is no argument that it emancipates language from its social and scholarly constraints. Consider Henry Giroux, a stellar figure in critical theory, who managed to write the following 80-word sentence:

> In this case, the notion of voice is developed around a politics of difference and community that is not rooted in simply a celebration of plurality, but rather in a particular form of human community that encourages and dignifies plurality as part of an ongoing effort to develop social relations in which all voices in their differences become unified in their efforts to identify and recall moments of human suffering and the need to overcome the conditions that perpetuate such suffering. (Giroux 1987, p.119)

What can one say? Critical theory abounds in such sentences – as stunningly revealed by the Sokal hoax where a hundreds of such sentences were randomly strung together and published in

a leading Critical Theory journal (Sokal & Bricmont 1998). The great pity is that it is from such sources that science educators are being urged to fill in the 'big picture' of science teaching.

DOES SCIENCE EDUCATION RESEARCH PROGRESS?

In chapter 9 Fensham addresses the question of 'evidence of progress' in the field. He cautions the reader that 'movement should not, however, be confused with progress' (p.134), and he uses the Illysian image of a 'butterfly moving from flower to flower' to warn that such movement is just 'replication', not progress. He rightly points out that the fact of lots of publications in a field does not necessarily mean there has been progress. But if mere movement is not progress, then what constitutes progress in a research field? Fensham skirts around this question.

Fensham does, chapter-by-chapter, work through his fourteen criteria of a research field and optimistically concludes that 'research in science education has realised an identity in some sub-areas of the large domain its researchers now occupy. In other sub-areas, such an identity still awaits' (p.209).

This conclusion avoids the question that many readers would be interested in, especially those readers in agencies that fund science education research: Has the research field told us anything about the world? More particularly, has it told us anything about how children learn science? What constitutes good and effective science teaching? What science content should be taught in primary and secondary schools? Should schools teach 'culturally-embedded science' (Harvard Project Physics), 'socially-relevant science (various STS programmes), or 'disciplinary science' (PSSC)? And so on. Having an identity and having knowledge are two different things.

It is clear that there can be thriving research fields that meet all of Fensham's 14 criteria, but nevertheless tell us nothing about the world; they are mistaken research fields. There may well be communities of researchers, conferences, journals, research methods, and implications for practice – some of Fensham's identifying criteria – but simply no knowledge created.

Such failed programmes are scattered over the natural and social science landscape. Think of Lyenskoist genetics in the Soviet Union which despite meeting all of Fensham's criteria, simply produced no knowledge of the world (and consequently produced disastrous recommendations for agricultural practice). Likewise think of the research community of phrenologists in Europe, UK, and the US in the early to late nineteenth century. They undoubtedly constituted a research field, and one that made numerous recommendations about medical, legal and social practice; but neither did they contribute knowledge about the world.

More recently think of the impact of behaviourism in learning theory. This constituted a huge research field, with numerous national and international conferences being held over a period of decades, scores of scholarly journals being published, tens of thousands of BA's and BSc's, and thousands of PhD's, were graduated, an enormous array of implications for the practice of classroom management, teaching and psychotherapy were promulgated, and so on. Was knowledge produced? The answer requires a long story, but in brief it is 'not much'. The academic mountain shook and produced a mouse (or perhaps one might say a rat).

In the above cases, and more can be added, there is lots of research activity – 'movement', and the being of the researchers were undoubtedly transformed, but one can reasonably ask was knowledge produced? In the above cases, the answer is no. What about research in science education?

Fensham does not pursue this question. His constructivist leanings make it a difficult one to ask. For most constructivists, certainly ones influenced by von Glasersfeld's epistemology, knowledge is whatever beliefs are viable in a person's experiential world. The problem is that many, if not most, mistaken views are completely viable to those who hold them. Thus, for constructivists, if 'progress' in a research field is linked to knowledge acquisition, then progress is indeterminate, new theories are progressive for some, and not progressive for others.

At one point Fensham says research is progressive if it 'has been progressive in the sense of understanding science classrooms' (p.133). This is both too narrow and too wide: too narrow, because there are lots of other specific things reasonably expected of science education research other than understanding classrooms; it is too wide, because just about anything can claim to be an 'understanding of science classrooms'. What does this claim possibly mean?

At another point he recognises that constructivism has for 25 years dominated science education research, and he proffers that 'assessing what has been achieved [by constructivism].... has been taken up by several authors' (p.135). He implies that the assessments indicate progress, but he does not elaborate.

It is a pity that this point was not pursued as appraising constructivism is a fitting test of whether science education research has produced knowledge and useful recommendations for the conduct and organisation of science teaching, or whether it has produced just mere publications - 'movement' - and 'personal transformation'. Contrary to Fensham, a number of researchers believe that constructivism has produced philosophical confusion (Nola 1997, 2003, Phillips 1995, 1997) and has misdirected educational effort (Matthews 1994, 2000). An examination of these rival claims would cast significant light on the overall question that Fensham is pursuing in the book.

CONCLUDING COMMENT

In his final chapter Fensham turns to studies on Language and Science education, and depressingly says that we see 'the same pattern of extensive borrowing of concepts and theories, with some attempts to indigenise them' (p.200). He recognizes that the research is of a 'derivative nature' (p.202), and adds that 'it is not uncommon for an author to cite, quite eclectically, researchers with different theoretical perspectives about language, as the inspiration for his/her study!' (p.208).

Yet the book gives rise to a puzzling question on just this matter. Fensham says that when he was first appointed to Monash University in 1967 'a masters degree in one of the foundations of education – history, philosophy, psychology and sociology – [was] a prerequisite for doctoral studies' (p.23). But he seems to have changed this requirement for science education doctorates: 'The first doctorate was completed in 1971 by the physics teacher who had been the project officer for the implementation of an adaptation of PSSC Physics into Victorian schools' (p.23). The changed, foundation-free, pattern is now the norm for science education doctoral programmes. This is in large part responsible for the faddish and shallow philosophical, psychological, historical, linguistic and sociological analyses in the field. After thirty years, it might be time to return to the 'old-fashioned' model of doctoral preparation, before the profession forgets that there was one.

Fensham concludes his book with the observation that science education research has matured and has, at least in some sub-areas 'realised an identity' (p.209). The following are some steps that might be taken to strengthen the identity:

1. Instead of science teachers doing higher degrees in education (with a view to university appointment), encourage them first to do an undergraduate degree in an appropriate foundation

discipline; after that do a PhD in Education. This is good for their personal growth or education, and it is ultimately beneficial to whatever research programme they might engage in

2. Ensure that PhD committees in science education have Foundations faculty on them. The participation of a psychology, philosophy, history or linguistics researcher on thesis committees would contribute to raising candidate and supervisor awareness of past and current literature in the relevant disciplines.

3. Try as much as possible to ease publication pressure so that scholarship can be engaged in. This might amount to getting institutions to trade off quantity for quality in appraising a new staff member's output. Institutions should recognise that one substantial, long shelf-life publication contributes more to the field than ten or twenty second-rate, shallow, ill thought-out publications. The latter merely muddy the academic waters. Far better for science educators to spend a semester attending a philosophy, psychology, linguistics or history course, and reading substantial books, than running around conducting yet another study of misconceptions or the impact of talking on classroom learning. Better that a few things be done well than a hundred things be done poorly.

4. Encourage a system of joint appointments between Education and foundation disciplines. Encouragingly this happens to a small extent between Education and science disciplines, if other faculty could be cross-appointed to philosophy or HPS or psychology, this would assuredly lift the quality of scholarship and research in the field.

Realistically however, the sad situation the field finds itself in is not going to change any time soon.

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12. Future Newsletter Items

Items for inclusion in the IHPST *Newsletter* are appreciated. These can be items for the 'Recent Research', 'Recent Books', 'Books' or 'Conferences' sections.

Please email newsletter material (or journal subscriptions or publication orders) to:

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Email: m.matthews@unsw.edu.au

13. IHPST Email List

This list is newly created. It is anticipated that it will be used sparingly, perhaps once a month, to send group information such as contained in this Newsletter. It is not a discussion forum list.

If you receive this email message and wish to remove yourself from the IHPST list, send a message to: majordomo@explode.unsw.edu.au . In the body of the message, not the subject line, simply write: 'unsubscribe ihpst-group'.

Alternatively, if you have friends or colleagues who would like to subscribe to the list, tell them to send a message to: majordomo@explode.unsw.edu.au . In the body of the message, not the subject line, simply write: 'subscribe ihpst-group'.