A Vision for Science Education

Responding to the work of Peter Fensham

Edited by Roger Cross

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One of the most important and consistent voices in the reform of science education over the last thirty years has been that of Peter Fensham. His vision of a democratic and socially responsible science education for all has inspired change in schools and colleges throughout the world. Often moving against the tide, Fensham has travelled the world to promote a more democratic science education. He was appointed Australia's first Professor of Science Education, and was later made a Member of the Order of Australia in recognition of his work in this emerging field of study.

In this unique book, leading science educators from around the world examine and discuss Fensham's key ideas. Each describes how his arguments, proposals and recommendations have affected their own practice, and extend and modify his message in light of current issues and trends in science education. The result is a vision for the future of science teaching internationally.

Teachers, researchers and academics in science education around the world will find this book a fascinating insight into the life and work of one of the foremost pioneers in science education. The book will also make inspiring reading for students intending to make a career of teaching science and technology.

Roger Cross is a Senior Lecturer in the Department of Science and Mathematics Education at the University of Melbourne, Australia. He, along with so many others, has been inspired by Peter Fensham's vision.

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To school students, for whom we hold the future in trust

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Contributors

Glen Aikenhead (Canada) has always embraced a humanistic perspective on science. This perspective was honed during his graduate studies at Harvard University and has guided his research and scholarly writing ever since. His current interests relate to cross-cultural science education for indigenous students. In 1990 Glen was awarded the Canadian Education Association Whitworth Award 'Canadian Educational Researcher of the Year'. In 1992 he received the Canada 125th Commemorative Medal for his research and development in science education nationally and internationally.

Nancy Brickhouse (USA) is an associate professor at the University of Delaware and editor of *Science Education*. She was educated at Baylor University and Purdue University in the USA in chemistry and education. Her research programme has been focused on issues of epistemology, gender, and culture in learning and the science curriculum.

Roger Cross (Australia) is a senior lecturer at the Department of Science and Mathematics Education, University of Melbourne. He was educated at London University and the University of Adelaide. His interests in Australian history and the social responsibility of science have been combined in his recently published book entitled *Fallout: Hedley Marston and the British bomb tests in Australia*. He has written five other books on education and science, including a recently co-edited book with Peter Fensham entitled *Science and the Citizen: For educators and the public*.

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Jim Gaskell (Canada) is a professor of science education in the Department of Curriculum Studies, University of British Columbia. His research interests include the social contexts of science curriculum, scientific and technological literacy, gender issues in science education, and the vocational/academic interface in school science. He is currently principal investigator of a federally funded project on 'applied academics'. He is also the North American representative to the International Organization for Science and Technology Education.

Richard Gunstone (Australia) joined Monash University in 1974 after twelve years of high school science/physics teaching. His research interests include student learning of, and engagement with science, metacognition, assessment, and teacher development. He has been most fortunate to have spent many years collaborating with Peter Fensham in research and teaching. He now holds the chair that was formerly Peter's.

Cliff Malcolm (South Africa) has been a professor in South Africa since 1997. This follows a distinguished career in Australia, where he led a major redevelopment of the science curriculum (k–12) in Victoria (1980s), and the design of the Australian outcomes-based framework (1990s). His contributions to government policies and frameworks, teacher support, and learning materials express his deep commitment to 'Science for All'.

Jonathan Osborne (UK) is a professor of science education at the Department of Education and Professional Studies, King's College London, where he has been since 1985. His major research interest lies in improving the quality of science education for the majority of students and teaching more about science. He was the co-editor, with Robin Millar, of the influential report *Beyond 2000: Science Education for the Future* and has since been involved in a number of projects on teaching the nature of science. A particular research focus is on enhancing the exploration of argument and its use in constructing and evaluating explanations and evidence.

Cristina Padolina (Philippines) Frustration at not seeing better achievement among many of her students, even after teaching as best as she knows how, led Cristina Damasco Padolina to the field of science education. She was drawn to this field soon after joining the University of the Philippines Los Baños in 1973 upon obtaining her PhD in organic chemistry from the University of Texas in Austin. This interest led to her involvement in teacher

education, to a post-baccalaureate Diploma in Science Teaching, to the first formal distance education programme in the University, and later in the establishment of the UP Open University with her as its first chancellor. After serving two terms, she went back to being a professor of chemistry, a stint she thoroughly enjoyed, but which was cut short when she was appointed Commissioner of the Commission on Higher Education. (She is now back to being simply a professor of chemistry, still maintaining an active interest in science education.)

Léonie Rennie (Australia) is Professor at the Science and Mathematics Education Centre at Curtin University of Technology, and Dean of Graduate Studies at the University. She has a background in science teaching and teacher education. Her research interests relate to how students learn science and technology, in both formal and informal settings, their attitudes about science and technology, and gender-inclusive assessment of cognitive and affective learning.

Tarsisius Sarkim (Indonesia) is a physics education lecturer at Sanata Dharma University, Yogyakarta, Indonesia. He is currently researching ways of reforming science teacher training in Indonesia. He has a particular interest in developing pedagogical content knowledge and constructivist methods in teacher training courses.

Joan Solomon (UK) taught science for more than twenty-five years in different high schools, mostly in the London area, and inaugurated the first STS course for state schools. She has been at the forefront of the STS movement and has developed a theoretical framework for STS curricula. She was awarded the first post as Lecturer in Educational Research at Oxford University where she ran some ten large research projects, and taught postgraduate students. She is now Senior Research Fellow at the Open University, and Visiting Professor at King's College London as well as at the Open University.

David Treagust (Australia) is Professor of Science Education in the Science and Mathematics Education Centre at Curtin University in Perth, Western Australia. He holds postgraduate degrees in science education from the University of Iowa and undergraduate qualifications in science from England and Australia. Prior to working in universities, he taught secondary school chemistry for ten years in England and Australia. He has published articles on student learning difficulties and approaches to alternative assessment on a number of topics in the secondary chemistry curricula. His research interests are related to understanding students' ideas about science concepts, and how these ideas contribute to conceptual change and can be used to enhance the design of curricula and teachers' classroom practice. He was President of the National Association for Research in Science teaching (1999–2001) and is the regional editor of the *International Journal of Science Education*.

James Wandersee (USA) taught high school biology for ten years, and then college biology for ten years, before becoming William LeBlanc Alumni Professor of Biology Education at Louisiana State University, where he directs the largest focused biology education research group in the USA. It has produced eighteen PhDs to date, and currently has twelve doctoral students in residence. His 15° Laboratory Group investigates the effects of visual approaches on biology learning – especially plant biology. He has also visited and presented his research at botanic gardens around the world – including the Royal Botanic Garden, Kew. Jim served as North American Editor of the *International Journal of Science Education*, and as the Associate Editor of the *Journal of Research in Science Teaching*. He was recently elected a Fellow of the AAAS in the Biological Sciences section.

Richard White (Australia) taught in high schools for ten years before studying for his PhD under Peter Fensham's supervision. As lecturer and later as Professor of Educational Psychology he was a close colleague of Peter's at Monash University from 1971 until Peter's retirement. Subsequently he served as Dean of the Faculty and then as Pro Vice-Chancellor for Monash in London. He helped Peter found the Australasian Science Education Research Association. He is the author of several books, including *Learning Science*, and many articles on science education, psychology, and research methods.

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This book would not have been possible without the wonderful support of the individual authors. They have given their time unstintingly to the task of projecting into the future Peter Fensham's contributions to science education. They are both representative of the vast number of professional contacts Peter has made over the years and among the leading science education researchers and teachers in their fields. It has been a pleasure to work with them on this project. They have given of their time freely and commend Peter on his choice of Amnesty International as the recipient charity of the royalties from this book. Amnesty International is especially appropriate given that the authors worked on their chapters during 2001. It is their expertise and vision that make this book a resource for those interested in furthering the cause of science education in the years to come.

I thank Professor Richard Gunstone, Faculty of Education, Monash University, Australia, long-time junior colleague of Peter Fensham and now occupying Fensham's chair at Monash, for enlightening me about Peter's work within the Faculty. My friend and mentor Ronald Price, emeritus scholar, La Trobe University, gave me support and encouragement along the way and read an early draft of my chapter.

I thank the Department of Science and Mathematics Education, University of Melbourne, for providing me with sufficient time and facilities to enable this work to be brought to completion.

Perhaps the most important person of all to thank is Peter Fensham himself. I first met Peter as a raw recruit to a sister institution (La Trobe University) and he encouraged my first tentative efforts to marry the social theory of the social responsibility of science to the science education curriculum. Increasingly, I have come, like so many others, to feel privileged to have met the man and shared ideas for the improvement of a democratic science education for all. I also thank Christine Fensham, Peter's wife, for her patience and her encouragement.

Peter knew nothing of the genesis of this project – but when informed, he willingly gave me his time. At the personal level it was a delight to learn something of Peter's life and interests. His scholarship is formidable and his memory equally impressive. To him I say thank you on behalf of all the authors, who

(except Mr Tarsisius Sarkim) have been enriched both professionally and personally by Peter. For my own part, let an Australian expression convey my gratitude: 'thanks, mate'.

Finally, I wish to acknowledge the love and support of my wife, Jenny Carter, whose own writings have inspired me and from whom I have learned so much.

Roger Cross
University of Melbourne
March 2002

Preface

In 1957 some of the world's greatest scientists heeded the call of Albert Einstein and Bertand Russell and met in the little town of Pugwash in Nova Scotia in Canada to discuss the fate of the world. So began the Pugwash Conferences of concerned scientists from around the world. At this and subsequent meetings scientists, almost unwittingly, acknowledged the enormous changes that had occurred in science as a result of two world wars (sometimes referred to as the 'Chemists' War' and the 'Physicists' War', respectively). Scientists were now thrust upon the world stage as actors in the decisions that would affect the fate of the world as we know it. The threat of rising levels of global radioactivity, especially strontium-90, galvanised Linus Pauling and others – thereby destroying the myth of a value-free science.

A 30-year-old Peter Fensham had, by this time, completed PhD degrees in both the physical and social sciences, and he had returned to his home town of Melbourne to become a physical scientist. As an academic scientist he did not fit the usual mould. Almost immediately (see Chapter 1) Peter Fensham showed his true colours by becoming a leading figure in Australia's own Pugwash movement. He was warned that involvement in such a movement might well be dangerous for a young scientist hoping to make his way through the ranks. What his friendly advisor did not realise was that Peter's career would take a curious turn away from research and teaching in the physical sciences into the muddy waters of research in, and reform of, science education. What was to become typical of Peter's work in the new and emerging field of science education research was the marrying of a strong sense of a democratic and collaborative approach to the solution of the difficulties science teachers found in their own classrooms and a grand vision for how people around the world might benefit from learning science at school. This perhaps unique attribute has helped Peter to connect with so many different cultural groups. They, like the authors of these chapters, recognised that this man saw through the petty barriers that divide different people, that the common good was also their good. That, I contend, is why we have collectively recognised the importance of his work and feel that it has much to say for the development of science education in the coming decades. While we recognise that Peter Fensham's work is not yet over, the major part of his corpus of work is now available

to us – and we hope that even he, with his marvellous physical energy and intellectual capacity, will agree with our assessment.

All of the contributors know and respect Peter professionally and socially (except our Indonesian contributor). Some know him very well, having been close colleagues at Monash University, others have come to know him through his internationally focused research, yet others are personal friends. We have been enriched in a variety of ways by our various contacts with him. I suspect that, like me, the authors have not always agreed with his vision for reform and have engaged in healthy debate based on different interpretations of the issues that confront us. This Peter has welcomed, and expected, for he has helped to create an open atmosphere where scholars can present ideas without the burden of a particular orthodoxy, for Peter's personal values and his training have ensured that he welcomes diversity. Indeed, rational debate is seen as a necessary feature of finding a way forward.

The authors invited to contribute to this book are among the world's foremost science educators. They have made very significant contributions to the field in their own cultural settings and beyond. The contributors represent Australia, Canada, Germany, Indonesia, The Netherlands, Philippines, South Africa, the UK and the USA. While this is not intended to be a *Who's Who* of science education research, it does represent a cross-section of people who are working in fields to which Peter has made significant contributions. They are, therefore, well placed to be able to assess critically the current issues and trends in science education.

Chapter 1, 'Living the dream: Peter James Fensham, social justice, and science education' by Roger Cross, enables the reader to gain an understanding of the man behind the ideas. This is an attempt to bridge the mind/body divide by providing the readers with sufficient knowledge to be able to determine why Fensham has acted in the way he has.

Chapter 2, 'Science for all: learner-centred science' by Cliff Malcolm, deals with the application of what is arguably Fensham's greatest achievement, championing the concept of 'Science for All' to the new South Africa. Malcolm takes the reader on a journey to the educational challenges confronting science teachers in South Africa as they reach out to their students – whose cultural expectations of the meaning of science and interpretations of phenomena are so different from the standard representations found in science textbooks around the world. Here, 'Science for All' needs to be reinterpreted in the light of enormous disparities in opportunity and cultural differences. Malcolm's answer is to learn from the public, science teachers, and their students.

In Chapter 3, 'Making science matter', Jonathan Osborne deals with what is arguably one of the most pressing issues in education for the twenty-first century. He deals with what kind of schooling of science should provide a basis for a democratic society in an era of increasing technological specialisation. He examines the key dilemmas facing us as we grapple with the issue of curriculum reform, and convincingly argues for a science education that is suitable both for those who may go on to specialise in a science-related career and for

the majority who will not. This is essential reading for all who are concerned about the role of science education in social construction and the value of teaching science.

Chapter 4, '"Science for All": reflections from Indonesia', by Tarsisius Sarkim, is a valuable addition to this book. Indonesia is part of an increasingly important area of the world, as are the Philippines, represented here by Cristina Padolina. Sarkim points to the contradictions and the dilemmas of 'Science for All' when applied to an archipelago of more than a thousand islands and the diverse cultures that make up modern Indonesia.

Chapter 5, 'STS education: a rose by any other name' by Glen Aikenhead, is a well-rounded review of the history of the science, technology, and society movement. It enables the reader to understand not only how this reform movement gathered momentum but also Fensham's contribution. Aikenhead comes to the conclusion 'that changing the status quo science curriculum cannot simply be achieved by STS-like curriculum innovations based on rational philosophical grounds alone'. He notes the importance of the socio-political in future efforts to reform, which is exactly Fensham's conclusion as his involvement in the OECD PISA (Programme for International Student Assessment) demonstrates by strongly advocating a different kind of testing – one that moves towards some of the principles of STS and the public understanding of science.

Chapter 6, 'The UK and the movement for science, technology, and society (STS) education', is written by Joan Solomon, the UK's most consistent advocate of STS. She examines Peter Fensham's contribution to STS and how his science education philosophy enabled him to link this reform with the broader ideas embedded in 'Science for All'. Solomon perceptively relates these dual threads in Fensham's work to the pioneering British scientist and educator Lancelot Hogben (see his famous book published in 1938, *Science for the Citizen*). She gives a complementary history of the STS movement, from a British perspective. Importantly, Solomon looks to the future through the lens of citizenship and ethics education as a process for a more democratic form of science education.

Chapter 7, 'Science for all? Science for girls? Which girls?' by Nancy Brickhouse, is a timely up-to-the-minute appraisal of some of the issues embedded in gender and science teaching. She begins by noting Fensham's contribution in this field and then deals with the problem from a US perspective. She draws into the net of gender both colour and socio-economic disadvantage and in this way an important step forward in the debate. Of equal importance is her perceptive analysis of identity formation, especially as applied to the different cultural and economic groups within the USA. The interpretation of achievement as a form of identity is a significant step that will enable other researchers to apply revised social theory to the question of gender and science education.

Chapter 8, Léonie Rennie's chapter entitled 'Understanding gender difference in science education: Peter Fensham's contribution', deals, in part, with the enigma of the research Peter carried out into gender differences in Thailand

with Sunee Klainin. This study was considered controversial at the time (1987) as it went against the accepted expectations. She points out that this study dispelled once and for all the proposition that biological differences accounted for differences in girls' performance in the physical sciences. Rennie then deals with a number of contemporary issues in this research paradigm and outlines a way forward that is complementary to Nancy's.

Chapter 9, 'Fenham's lodestar criterion' by James Wandersee, is a highly original and thought provoking development of some of Fensham's work in the theory and practice of science education. The 'lodestar' according to Wandersee is 'a star to steer by', and he states that 'Peter Fensham's sustained interest in using student-appropriate personal, societal, and technological applications of science to teach science in understandable ways indicates that he has long weighed science teaching outcomes on a ''usefulness to students'' balance.' Also, '[m]any of his research studies can be viewed as investigations intent on informing the construction of better science curricula and/or improving science instruction that maintain scientific integrity while insuring utilitarian value for students'. Wandersee deals with these issues from a US perspective.

Chapter 10, 'Partners or opponents: the role of academic scientists in secondary science education' by Harrie Eijkelhof, discusses the role of politics in the construction of the science curriculum. Eijkelhof's intimate knowledge of the role of politics in education in The Netherlands, especially the competing forces acting upon physics education, makes for illuminating reading. He shows us ways in which these forces might be accommodated via collaborative partnerships that allow different stakeholders to participate in future changes in what counts for the schooling of science.

Chapter 11, 'Perspectives and possibilities in the politics of science curriculum' by Jim Gaskell, provides an important analysis of the influence of academic scientists as guardians of the 'purity of school science'. Jim's account is all the more appropriate for this book because Peter Fensham himself was once an academic scientist, albeit a highly unusual one. Gaskell's analysis goes much further than this – he uses the Canadian situation to illustrate the exercise of power over what counts for the science curriculum in schools, and provides readers with thought provoking ways of engaging with powerful players in the field.

Chapter 12, 'Visions, research, and school practice', places Peter's work in the context of German students' achievements in international science testing. Reinders Duit deals with the problem of the meaning of scientific literacy in terms of a constructivist perspective and whether or not science education research has had any impact on teachers' work. He deals with Fensham's vision of 'Science for All' and illustrates how this has been interpreted in the professional work being done in Germany to bridge the gap between expectations about the results of international testing and the recent findings. This is another profoundly important statement about the possible future course of science education research.

In Chapter 13, Richard White's 'Changing the script for science teaching', he begins by explaining the meaning of 'script' – that it is knowledge of how to behave and, therefore, what our expectations are about social structures. The script of schools and schooling 'reflects the belief that schooling is for the acquisition of knowledge, which is needed for two purposes: to equip students for employment, and to prepare them for further study of the same sort of knowledge. The script guides the behaviour of teachers, students, parents, curriculum designers, examiners, administrators, and governments.' He goes on to analyse the teaching script in a way that challenges Peter Fensham's long-held articles of 'faith' regarding the possibilities for reform.

Chapter 14, 'Impact of science education now and in the future', deals with ways in which science education is seen to have contributed to life in the Philippines. Cristina Padolina is uniquely placed in the Philippines to explain the importance of Fensham's 'Science for All' as an inspiration, and as a way of developing appropriate experiences to diverse communities within one country. She provides the reader with a refreshingly different perspective on the issues with which Peter has grappled.

David Treagust writes Chapter 15 from both personal and professional perspectives. His chapter is entitled 'The importance of being able to see ''the big picture'': a personal appraisal of Fensham's influence on science education research and development'. In it he discusses Fensham's uncanny ability to bring 'diverse ideas together' when considering the complex problems of teaching and learning. Treagust amply illustrates the importance of the 'big picture' with respect to conceptions of scientific literacy and how we might advance scientific literacy. He offers valuable suggestions for a way forward by drawing on some of his own research.

Richard Gunstone has written the Afterword; he describes a joint project between Monash University and King's College London. It was one of Peter Fensham's visions to establish an international centre for research into the science curriculum. This has now become a reality under the guiding hand of the professors of science education at Monash and King's. Gunstone describes how the joint centre was established and the kinds of research questions it will address.

Appendix 1 is a list of selected publications from Peter Fensham's enormous output in the field. At the time of writing it is worth noting that he has just completed the manuscript of another book that describes the emergence of the field of science education research. Its title is *Evolution of Science Education as a Field of Research*. How appropriate it is that this should be written by him.

Part I

Peter James Fensham (1927–)

1 Living the dream

Peter James Fensham, social justice, and science education

Roger Cross

In beginning to contemplate my account of Peter Fensham's life I am acutely aware that this cannot be a biography, even though his full and interesting life would make a fascinating story. It will, however, be biographical – for how else can we begin to appreciate what has driven Peter to the four corners of the world in the cause of enhancing our understanding and knowledge of science and its teaching for nearly forty years? I will try and give you an insight into this remarkable man's life without taking away from the essential purpose of this volume. Also, I must not 'steal the thunder' of the distinguished scholars who will be discussing his work and how it might be carried forward. As to literary style I am in 'no man's land' somewhere between a *Who's Who* entry and a retirement speech given by a colleague. What genre of writing can help in this dilemma? For better or worse I have laid out what seems to have been Peter's journey through life to the point of finding his métier and then dealt briefly with how one of the major intellectual themes in his quest for the reform of science education arose. It will be up to you to judge whether this gives you sufficient insight to form a judgement about the intellectual and emotional attachment that Peter has for his quest to promote a fairer world.

Finding a way: Peter James Fensham, AM, BSc Hons, MSc (Melbourne), PhD (Bristol), PhD(Cantab.), Dip Ed (Monash)

Here is a man who has lead a remarkably active life, a life that from the outside looks obsessive in its drive, and compulsive in its search for a better and fairer way ahead for all societies – a search for social justice. A man, his Monash colleagues say, who you are as likely to meet in some out of the way corner of the world promoting his vision as you are to come across in his hometown of Melbourne. In trying to understand what Peter has been endeavouring to do all these years, it is necessary to revisit how he came to be Australia's first professor of science education. I realise that in doing this there is a danger of a Festschrift – simply a celebration of his work. However laudable that might be, it is not the point of this book. Nevertheless, it is important to understand something of what drove Peter to pursue certain avenues of work, and how he

came to think the way he does. This will help you in forming your own judgement about the breadth and depth of Peter Fensham's work, his obsessions, his strengths and weaknesses that have been a part of his long campaign for a more just society – through the medium of teaching science. Like us all, Peter carries the baggage of his past and projects it still into his work. Like the scientist he once was, he cannot divorce his values, his personal agenda, from the claims he makes for the improvement of science teaching.

I will try and reveal something of Peter's life's adventure, and his strong sense of calling and mission – a mission that is evident in every conversation he has about his beloved personal themes: how to make our world a more comprehensible place, and a more interesting place in which to live. Let one of his favourite books help us approach an understanding of this man: *A Fortunate Man* by John Berger and Jean Mohr (1967). This slim volume tells the struggles of a country doctor, Dr John Sassall, who worked in England among largely unschooled foresters who seemed left behind by the pace of change, and were largely despised by the changed population in the cities. Sassall gradually comes to admire their hidden strengths, their folk knowledge, and their essential goodness. In this journey Sassall finds himself in the course of a life where a feeling of adventure has nothing to do with exciting events. This is so apt for Peter – who has spent half a lifetime in the air and in airports – for each moment appears to be an adventure of the mind. It was said by his colleagues at Monash: beware Fensham fresh from a long journey from half way round the world! The ideas pour forth, gestated within the bowels of an aluminium bird (Gunstone, 2001). For Peter, as we shall see, has found (like all mortals) that time is irreversible but the mistakes in teaching science are not. They have occurred over and over, leading him on to new battlegrounds, and it seems that the defensive and offensive strategies are best formulated over a plate of plastic food and a turbulent ride.

Peter Fensham was born in Melbourne in October 1927, the year that saw Lindbergh as the first man to fly solo across the Atlantic, that the Australian Parliament first sat in Canberra, that Al Johnson starred in the first talkie film immortalising the line: 'You ain't heard nothin' yet' (prophetically capped by science's Werner Heisenberg's 'Uncertainty Principle'); no wonder, some might say, that he turned out the way he has!

He grew up at a time where universal secondary education had not yet been completely established in Victoria, and his earliest years were lived through the Great Depression. As luck would have it, he went to strongly academic schools for his primary and first years of secondary education. Gifted students could find their way to higher education, and so it was with Peter. He was awarded a scholarship to the prestigious private school, Melbourne Grammar School. This was to be an important moment in his life: MGS, along with one or two other schools, was the closest thing to an elite English public school in Australia. It immediately opened its doors to those boys with wealthy parents, or scholarship boys like Peter who provided the intellectual backbone of the school. He qualified a year early for university at the age of 17, and decided

not to stay on for another year but to try his luck at university. He was fortunate that the year was 1945 and the war ended just before his 18th birthday. He was thus able to continue his studies rather than be called up for active war service. It is hard for us who were not adolescents at that time to understand how that terrible war may have affected young people's lives and their vision of what life should be. For the youth of a country that was drawn into effective nationhood through the experience of our armed forces at Gallipoli in the First World War, to have missed active service was certainly a blessing – but could it also be a burden for Australian men? I have often wondered how it affected those men, Peter included, who could never be a part of the Australian mateship of the Returned Services League (RSL) and could never share in the dubious glory of being a veteran. I speculate that this was an important factor in the life of this restless and energetic man. Many other factors have, of course, contributed to his sense of social justice, including, I believe, his personal beliefs, and his Protestant church upbringing.

Studying science rather than medicine at university – the normal choice of profession for high-flying MGS boys – must have come as something of a surprise to the School. But Peter had what he thought was a wise plan: science studies took three years at university, not six as with medicine. Never did he think that he would be studying for the next twelve years! After his Bachelor's degree he went on to do a Master's degree – Australia's top scientific qualification, at that time. As chance would have it, his supervisor was a man who was to have tremendous influence on him, so much so that, along with Peter's non-conformist Christian faith, it was crucial for his working life. Dr Walter Boas, a leading CSIRO (Commonwealth Scientific and Industrial Research Organisation) physical metallurgist, came to Australia from Switzerland in 1938. He had a strong belief in the responsibilities of science and became prominent in Australia's Pugwash movement – the peace movement initiated by Einstein and Russell in the search for peace (Russell, 1961, pp. 55–61). The Pugwash group was largely responsible for the campaign to end atmospheric testing of nuclear weapons in the 1950s. Peter says of Walter: 'He was a very great influence both scientifically and what science means in society' (Fensham, 2001). After completing his Master's degree he was successful in obtaining the prestigious Exhibition 1851 Research Scholarship. So off he went to the University of Bristol, England, to research for a PhD in the field of solid state chemistry.

While in Bristol Peter met Christine, an Edinburgh University biochemist, and they were to marry some years later. In 1952 Peter went to Princeton University as a postdoctoral fellow to work with Hugh Stott Taylor, a famous physical chemist, and his career in chemistry was launched. Perhaps it was the allure of Christine, perhaps too he was still searching for his true vocation, but chemistry was about to take a back seat for a while! While in Princeton he met Professor Hadlee Cantrill, the social psychologist, and discussed with him the idea of studying social psychology. Perhaps this idea would have come to nothing if it hadn't been for a stroke of luck – one of the strange quirks of fate

that are a part of every life – when the British Nuffield Foundation advertised scholarships for people who wished to make the switch from natural science to the social sciences. At this opportune time Sir Frederick Bartlett, the famous Cambridge psychologist, visited Princeton, and on meeting him Peter was persuaded to apply for one of the Nuffield scholarships at Cambridge – a place, Bartlett told Peter, that would 'give you some freedom to find your way' (Fensham, 2001). This was a 'long shot' for Peter: the scholarships were intended for British subjects, not Australians, and he was a late applicant. He was told at the interview that he broke all the rules. With this daunting interview over he spent the rest of the day watching test cricket across the road at Lords!

The Australian must have been on a good batting wicket, however, because despite all the rules he was offered a scholarship at London University. I'm afraid Peter further confounded the Nuffield Foundation by telling them that he would have to take it up at Cambridge and not at their nominated university. One happy result of returning to England for the interview, and the new intellectual mountain he hoped to climb, was his subsequent marriage to Christine in Bristol in April 1954. He successfully completed his second PhD in 1956 after having met some of the most significant Anglo-American scholars in the field. He had by now developed a holistic approach to dealing with complex problems of human society, one that would stand him in good stead in the years to come.

But the Antipodes were calling and the search began for a post back home. Naively he thought that the premier social psychology department in Australia, at his old university, Melbourne, might provide an opening. But it was full of positivists, and they, he discovered later, found little of value in his thesis. (It is worth noting here that his thesis was published as a book, and the publishers, Taylor & Francis, through their Tavistock Press imprint, are about to reprint classic works in psychology. Not surprisingly Peter's is among the list. How many of the Melbourne positivists can claim that?!)

With bread and butter for a young family the priority, it was imperative to find a job and so social science lost him to chemistry. Determined to continue his life in Australia, he turned again to his first love and was appointed to the Chemistry Department at the University of Melbourne as a solid state chemist. His calm recording of these facts today belies what, I believe, must have been a deep sense of disappointment and frustration. Knowing Peter as we do, there was no question of letting disappointment stand in his way. He threw himself back into the world of chemistry and soon began to climb the academic ladder. At some risk to his career he became an active member of the Australian Pugwash movement in Melbourne during a time when the organisation was decidedly too radical for the Australian government. In 1963 he became aware of Bloom's taxonomy and seized on the idea of conducting an educational study on his own chemistry students – this would bring him a little closer to his work in psychology. The study was published by The Royal Australian Chemical Institute, and to his amazement the editor of *Nature*

contacted him at a time when the first glimmering of interest in improving the quality of university teaching was appearing. It was quite a thrill to see the article appearing in *Nature* in 1964.

Peter became chairman of the Melbourne Pugwash Group while still a chemist, and in the 1960s he was approached by Joseph Rotblat, president of the international organisation, with the idea of holding a South East Asia Pugwash Conference. This was the time of the Vietnam War and it was thought that such a conference – without the USA or the Soviet Union – might encourage China to participate. In the end the group didn't manage to persuade the Chinese to participate, but thirteen other South East Asian countries attended.

By now he was a reader in chemistry and the possibility of a chair in chemistry was looming fast. He reluctantly declined the chair in chemistry at the new University of New Guinea, and found the new University of Loughborough painfully slow in making the offer. Peter came to the notice of Louis Matherson, Vice-Chancellor of Monash University (having interviewed him for both of these posts), and he told Selby Smith, the Dean of the Faculty of Education. Smith was trying to establish his Vice-Chancellor's vision for the University to be at the forefront of research – and he duly appointed Peter. This was to change Peter's life again, this time in a way that would marry physical and social science in the one man. He was invited to apply for the first chair in science education in Australia, and so again he jumped ship – for the last time. He moved to Monash in September 1967 and didn't look back. Now working for young people's futures instead of with chemicals, he had come full circle, and while never a medical practitioner like so many other successful boys at MGS, he would be totally immersed in people's lives.

Before long he had five PhD students, among them Richard White, one of the contributors to this book. His job was to build up as quickly as possible his university's international reputation for research in this new and emerging field of study. The decade 1967–77 was one of frenetic activity. His initial sortie overseas in 1968, when crucial links were forged, paved the way for Monash's name to be synonymous with science education around the world. Luck again intervened on the home front. After years of neglect by the federal conservative government, Gough Whitlam's reformist Labor government opened the purse strings to school education.

As far as his work in science education is concerned he is wholly responsible for establishing science education as a legitimate field of research in Australia. His ex-students now hold chairs and senior positions around the country, and he has encouraged and helped many other academics (like myself). Perhaps the single most important event in the early years was the conference he organised in 1970, the first meeting of the Australasian Science Education Research Association (ASERA), the second such organisation in the world (the first being NARST in the USA). The first ASERA proceedings appeared in 1971. That year, too, he also became the first elected president of the Australian Science Teachers' Association.

By 1977 the Faculty of Education at Monash was producing between a third and a half of all the PhDs in education in Australia and it was the only faculty in the country that had more postgraduate enrolments than initial teacher training. This was an unbelievably vibrant academic community and at the summit was Peter, always approachable and full of ideas. As Richard Gunstone, the present incumbent of his chair at Monash, says:

> He had a huge impact on me – he improved and validated the whole research area. The great luck of my professional life has been working with Peter Fensham . . . I can't conceive of a greater professional opportunity. Peter has the capacity to consider multiple issues at once that is most impressive. The description I could never apply to Peter is Prima Donna [*sic*].
>
> (Gunstone, 2001)

In 1975 he was invited to succeed Kevin Keohane as the Director of the Centre for Science and Mathematics Education, Chelsea College, London (now part of King's College), but family ties kept him at Monash. Other job offers have come his way from time to time, but the world was coming to Monash, so why move? During the twenty years spanning 1970–90 there was a constant stream of science educators from all over the world on pilgrimage to Monash, many of them hosted personally by Peter in his own home.

He has been responsible for very many initiatives, both internationally and in his home state of Victoria. One close to my heart is his work in environmental science education. In 1973–4 he was the Australian representative for the famous UNESCO Conference in Belgrade (see 'The Belgrade Charter: A global framework for environmental education', *Connect*, 1(1), 1976), at which the founding international principles for environmental education were laid down in a historic document called 'The Belgrade Charter for Environmental Education'. Peter fondly remembers this conference for the way the ideas evolved:

> the first day the [organised] programme was totally overturned by some of the delegates from developing countries . . . we spent four of the seven days hammering out the Charter until we knew what we were talking about, and the real depth of the problem. That was a very famous moment . . . I remember the Peruvian [representative] saying [to me] could you ask that European speaker to stop speaking about 'aid' because you [the First World] have ripped us off so much that there is no way you can pay this back, so let's just forget about aid and think about some other way of expressing the relationship we are trying to have? Aid, after all, was half the problem.

Peter was in the forefront of awaking interest in Australia in environmental education. He chaired the regional meeting on environmental education for

UNESCO in Bangkok, and was the Australian government's representative at the inter-governmental conference on environmental education at Tbilisi (resulting in the Tbilisi Declaration, see *Connect*, 3(1), 1978). He became the founding president of the Australian Association for Environmental Education in 1981.

In the 1970s at the local level, in his own state of Victoria, he introduced and supported a new senior secondary science subject called physical science, and strongly supported a second, environmental science. These subjects were the beginning of the Science, Technology, and Society (STS) movement in Australia, another one of Peter's major interests – as you would expect from his personal history.

Perhaps rather reluctantly, Peter's globetrotting, promoting the causes dear to him like 'Science For All', was moderated by a seven-year stint as Dean of the Faculty, at Monash, 1982–9. During this time he received one of the highest Australian honours, an AM (Member of the Order of Australia). Four years remained before he retired from his chair in 1993. Throughout this time he continued to develop links with people in other countries. Anyone would think that after a lifetime of such intense activity Peter might put his feet up and reflect on his achievements. Not a bit of it. Since retirement he has constantly worked at promoting the cause of a more democratic and socially responsible science education for all. The undiminished stream of scholarly publications and his many travels to all parts of the world to collaborate with old friends and encourage new researchers in the field are a testament to his energy and to his personal ethics – of giving of himself unhesitatingly. It has been remarked by many that Peter will always respond to the call for help. In 1999 Peter was awarded the NARST's Distinguished Contribution Award; there can be no greater recognition than this. Here, indeed, is proof that Peter Fensham, the passionate Australian who championed the teaching of a particular kind of science in the best interests of all, has been recognised for what he is: a man of integrity and principle, and one of the few truly important figures in the field. A man for his time, bringing people together in a common cause from whatever corner of the world they live, to counteract inequality. The citation for the NARST award includes the following:

> [He] has provided outstanding leadership and direction in science education research. The remarkable and distinctive feature of his research contributions has been his capacity to discern and synthesize key issues in science education. . . . Professor Fensham's significant and outstanding accomplishments make him a worthy recipient of this prestigious award for life-time achievement in science education research.

Peter remains committed to his ideals, and, as a member of the Science Group of the OECD Programme for International Student Assessment (PISA) project has had considerable influence in ensuring that future international testing of students for science now involves the application and understanding of

science in society, which he sees as necessary for a more holistic and democratic schooling of science.

Peter has enormous energy and is extremely fit – from being able to hike in the Tasmanian wilderness and 'Walking for Want' (an annual event that he always completes, ensuring that his friends dig deep). Richard Gunstone tells me that on one occasion he met Peter in Vancouver, and on arrival, instead of succumbing to jet lag, he immediately went to work contacting people and holding discussions. Richard remarked that Peter has the uncanny knack of coming off a transpacific flight as if he had walked down the corridor of the Faculty at Monash for morning tea! How does he do it?

Research: a way is found, 'Science for All'

I am very much aware that I must not pre-empt the following discussions of Peter's many contributions to science education research and theory. Distinguished writers will be placing his work in a number of different areas in the context of the possible future developments of his science education philosophy. Here I will only consider his underlying philosophical position embodied in 'Science for All'. This has meant so much to him. The fact that he has been steadfast in promoting a particular approach to the schooling of science over so many years illustrates how close to his heart it is. In other words, his commitment reveals a great deal about the nature of the man. One speaks of social justice in the same sentence as one speaks of Fensham's collective effort in science education. This is, of course, not surprising. A person's value system and vision of an ethical life, and even morality, are all to be found in a life's work. In Peter's case it is particularly clear – for more than thirty years he has been displaying what he is for anyone who cared to look. His values shine like a beacon through his writing, in his research programmes, and the causes that he holds dear show. In discussing these matters with Peter I was struck by his generosity towards all those colleagues who have, as he says, enriched his life and helped to formulate the way forward. It is fitting that his promotion of the ideas underpinning his enduring slogan 'Science For All' can represent the man as much as it can represent a new way of thinking about the teaching of science. This is the core of the rest of his work, the unifying factor that has informed all that he stands for. It is to this value statement, which now seems so self-evident, that we must turn if we are to understand how Peter's views beyond teaching have determined his way forward.

In 1968 during Peter's first full year at Monash his sense of social justice and, I suspect, his personal religious beliefs came to the fore with the twentieth anniversary of the United Nations Declaration of Human Rights. Since he was intimately involved in the United Nations Association it was natural for the Association to ask him to convene some meetings to mark the occasion. These were a great success and, importantly, a book was produced that was to become highly significant to Peter and, as it happened, to national events in Australia. *Rights and Inequalities in Australian Education* finally appeared in

1970 and quickly became a seminal text in Fensham's philosophy, guiding his work in the years to come. Nationally, Australian education was moribund; its elitist structure was a product of the colonial past. The flood of children from post-war migration from all over Europe was now entering secondary school and Australia was about to change for ever. Peter became aware that one of the greatest causes of inequality in education was science itself – it was male dominated and elitist, favouring the very few and barring many from those professions that relied on the study of science as a prerequisite for entry. For the first time, publicly at least, it was possible to explain why Fensham had 'deserted' scientific research in favour of social science and climbed the mountain required to become qualified in that field. Here, I suggest, is that moment in his life that defined the way forward. Added to his left-leaning politics and his faith, this project gave him a cause – notwithstanding that he was a product of one of the most elite schools in the country. *Rights and Inequalities* was an influence far beyond academic circles. Gough Whitlam swept into the Prime Minister's Office on the 5 December 1972; his reforming Labor government established a number of socially relevant institutions, including the Schools Commission. The book became something of a bible for that organisation which was hell-bent on addressing educational disadvantage. Peter (2001) says: '[these events] alerted me very strongly to [the] conditions of social disadvantage that led to educational disadvantage'. Here, for the first time, the federal government began to take a real interest in encouraging educational programmes in schools, normally the preserve of the individual states. Peter advised the commissioners on how an innovation programme would fit into the overall philosophy of initiatives based on educational needs and disadvantage. It led to a decade of fascinating innovation and a great boost to the morale of teachers. This was a time when Australia underwent many reforms, and the climate of debate and desire for change in the country from 1972 to 1975 was conducive to Peter further developing his ideas surrounding 'Science for All'. He became increasingly aware that

> we had to create a form of science [education] that was attractive in ways, which were different to the way it had been attractive to me and to most people in the science education field, because we were the exceptions. For some reason we had stuck with science where most of our peers had rejected science at school as being boring, too difficult, or totally irrelevant.

Here we see his final transformation from the successful scientist to a science educator who recognised that what made him pursue science as a career was unsustainable in the sense of the changed world in which he lived. He acknowledges the committee who worked on the new Victorian senior science, STS-like course called 'Physical Science' (mentioned above). It was, he recalls, one of his most satisfying experiences. Traditional views of what constituted a science course were challenged: they (the teachers) 'were fantastic, because when I suggested things that could go in they said what about your criteria

of relevance? Things dear to my [scientist] heart were rejected [by the teachers I worked with]' (Fensham, 2001). He had to fight tooth and nail to have the course accredited by the universities and the scars of that process illustrate how entrenched the old ways were (and are today), and how difficult the road ahead was, and still is, for that matter.

We come now to the formulation of 'Science for All' as a holistic viewpoint of the purpose of teaching science in schools. The leap across the divide of science for its own sake to science as an educational tool had been made and Peter had, by now, incorporated fully his personal values and his ideology into this conceptual framework. It can be seen as a socio-political statement, just as much as it can be seen as logical for the times in which he formulated the concept. He was greatly affected by his involvement with UNESCO, and the revelation that science could be transformed into useful knowledge came, in part, through his contacts in Bangkok. 'Science for All' has become far more than a convenient slogan with which to capture the attention of the bureaucrats – it is a way of teaching science for a broad social purpose. It involves useful scientific knowledge, and ways of thinking and doing that could help all future citizens to lead fulfilling lives. With the arrival of the 1980s, 'Science for All' was to become the dominant theme of concern among science educators around the world. 'Science for All Americans' and 'Science for All Canadians', and even the staid Royal Society of London took up the theme in 1985 in its document *Public Understanding of Science*. Its message was incorporated into the STS and the 'Girls in Science' projects of the time. It was an underlying theme of the important movements for reform throughout the period. Science was to be open to all under its banner and the elitist structure of science teaching and the curriculum began to break down.

Let us consider briefly the STS movement and the 'Science for All' theme. Peter notes that the rapid growth in the number of people wishing to be seen as part of the reform led to much confusion about the underlying principles and purpose of STS. This lack of coherence in the understanding of STS was nowhere more evident than at the famous Bangalore Conference in India in 1985. The papers presented illustrated an enormous disparity of views, from the most traditional and elitist to some highly radical and innovative programmes. The muddle and lack of coherence inhibited the implementation and the promising support of 'Science For All' – something that Professors Joan Solomon and Glen Aikenhead discuss in their chapters. Another important issue that caused him concern was the impact of the Alternative Frameworks research programme – in which he had been prominent in its early years. He states:

> In 1989 I tried to find out what had been done in terms of STS type concepts within Children's Science – there was almost nothing done . . . all the evidence was based on traditional concepts. Implying too readily that all that had to be done was to teach the old subject matter better

> and all would be well! Sadly we now have a burst of new curricula, with a constructivist sort of mantra to them, but the content is still the same.
> (Fensham, 2001)

The relationship between Peter's ideas and STS can perhaps be best seen by examining some of the Dutch PLON physics units. They closely relate to his own work of a decade earlier on the physical science course in Victoria. PLON gave a glimmer of how science might be taught – the similarity of purpose with Peter's early efforts is striking.

In his paper in the *International Journal of Science Education* (Fensham, 1988) dealing with approaches to STS, he proposed that if you wanted to emphasise the nature of science in relation to certain content you would focus on 'Science' in STS; if you were interested in people and social interactions you would focus on 'Society' in STS; and if you were interested in the technological innovation you would focus on the 'Technology' of STS. You allow, he says 'each to be the drivers, of the content or the focal point of the teaching of content. Whereas, so many of the so-called STS curricula were saying well just add on a bit of application in society in traditional [content].'

Conclusion

I have highlighted 'Science for All' here to illustrate what I believe is Peter's underlying educational philosophy. It is, of course, but one of the research themes to which Peter has been deeply committed. His work is ongoing, and his influence in the OECD Programme for International Student Assessment project is testament to the way his advice and his wise counsel are still at the forefront of international developments in science education. The fact that his life's work is not completed has made this slight contribution to understanding the man a more difficult task.

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