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ACCESS

BOOK REVIEWS

Challenging New Zealand science education, by M. Matthews, Palmerston North, Dunmore Press, 1995.

On the day I began to write this review of Michael Matthews' book, *Challenging New Zealand Science Education,* I received a copy of a monograph collated by Beverley Bell which consists of a variety of responses to his work. The critiques make interesting reading, representing as they do a challenge to the challenge, and furthering the debate which Matthews intended. I leave it to others to identify what they take to be factual errors, and misconceptions about such matters as the work of the Centre for Science, Mathematics and Technology Education Research at the University of Waikato, Maori science education, feminism and science education, and the science education programme at the Auckland College of Education. Rather, I shall briefly describe the content of the book and then pass some comment on several philosophical issues raised by Matthews and his critics.

There is no doubt that Matthews' book is polemical, as was intended. Its target is constructivism in science education, and the enemy are those constructivists in the Centre for Science, Mathematics and Technology Education Research of the University of Waikato whom he takes to have perverted the nature of science education in New Zealand and had an unduly harmful influence on the revision and development of science education curricula in this county. He is no admirer of constructivism in any shape or form, nor does he appear to be drawn to constructivists at a personal level. Of the personal, the ad hominem attacks made by both parties have a marked tendency to obscure more important issues to do with science education. As to whether constructivism provides an adequate account of knowledge, learning, science and the like, this is another matter altogether warranting more rigorous attention.

Matthews' book consists of eight chapters, many of which are revisions of earlier published *g,* and unpublished works. This in itself is not illegitimate, but it can lead to a measure of discontinuity and repetition, as is apparent here. The first chapter discusses the cultural importance of science education with an examination of the influence of constructivism on science education and the public controversy over this influence in 1989 and 1993. (For the media debate in 1995 following the publication of the book, and Matthews' tour through the country to promote it and confront defender and critic alike, see the above mentioned monograph by Bell which has a section containing media coverage). The second chapter places constructivism in a wider educational context by looking at the situation in Australia and the United States, along with the literacy debate, the English curriculum, reading and mathematical achievement by trainee teachers in this country. In the third chapter, we start to get closer to the target. Constructivism in its various guises is discussed: the writings of Kuhn in the philosophy of science, of Bloor and Barnes in the sociology of scientific knowledge, and educational constructivism exemplified by von Glasersfeld and the *Waikato constructivists* are frequently cited. Matthews attacks two doctrines which he identifies as being central to the Waikato constructivist programme: sensism - science as a way of making sense of the world, and subjectivism - knowledge as a personal construct. We shall return to these doctrines later. In chapter four, Matthews thinks that constructivism has some redeeming features, particularly its emphasis on finding out what children think, teaching for understanding, and active learning. He is dismayed by what he sees as its limitations. His criticism centres on his concern that a constructivist curriculum neglects content with its focus on process, and its avoidance of serious thought over the aims of education. Here, the work of various philosophers of education is appealed to, including Dearden, Peters, Scheffler and Strike. This is followed by a fifth chapter on

epistemology and constructivism, in which Matthews discusses what he takes to be three major problems of constructivism epistemology - its acceptance of empiricism rather than realism, or of sense data rather than things in the world; its instrumentalism - when we posit unobservables to explain what we observe, realism takes these unobservables to be ontologically real while instrumentalists hold such posits to be useful fictions; and its individualism - that the construction of knowledge is an individual matter rather than being a social process of learning socially generated concepts. Matthews will have none of this. In chapter six we find ourselves addressing problems for New Zealand science education. A range of topical issues are traversed - misguided teacher education, particularly in science education and student-centred teaching; women and science, especially feminist views; Maori science education - the compatibility of Maori beliefs and Western science and the universality of science; and the neglect of the conceptual structure of science in the science curriculum. Throughout the book, Matthews advocates a liberal approach to science teaching, and in chapter seven he discusses two examples - pendulum motion and air pressure. Here he raises some epistemological issues, considers some pedagogical lessons, and contrasts two teaching styles. In the eighth, and final, chapter, a liberal approach to teacher education is developed in some detail. The contributions of history and philosophy to science teaching are examined and an argument for their inclusion in teacher education is made. Matters such as whose history and whose philosophy are also addressed. Matthews' conclusion: constructivism, as a doctrine, is erroneous in its philosophy and deleterious in its social consequences - New Zealand education would be better served without it.

It is a pity that Matthews' book contains as much rhetoric and polemic as it does, for these tend to overshadow the more important aspects of his critique of constructivism. In addition, while his target is constructivism in the New Zealand science curriculum, he broadens the scope of his attack so much that his efforts have more the appearance of a shotgun blast than the deadly effect of a well-aimed shot - literacy, English, reading, mathematics and peripheral versions of constructivism all get roped in. Matthews rightly points out that there are many varieties of constructivism but this presents him with a problem - much of his effort is directed towards aspects of constructivism which New Zealand constructivists disavow. He would have been on stronger territory if his attention had been limited to a more focused analysis of the assumptions underpinning the local version of constructivism. However, once stripped of its more superficial features which get his critics so worked up, Matthews' discussion of constructivism does raise some important philosophical matters which deserve further consideration.

Before commenting on the two assumptions of constructivism which Matthews finds so troubling, I would make a passing observation about something which philosophers such as he and I find irksome. Being ignorant of much of the theoretical content of science I, and others, are usually reluctant to pass judgement on science except in the most general terms. Now, while philosophy is not the province of philosophers alone, I never cease to be amazed at the boldness of those in education who, not being philosophers, are so ready to pronounce on matters they are, to a large extent, ignorant about. Their views on ontology and epistemology, knowledge and truth, and the like, all too often reflect a lack of awareness that philosophers have been discussing these things for over 2000 years and what they have had to say might be important to take into account in contemporary educational discourse. Since scientists (and science educators) tend to ignore the history and philosophy of science I suppose it is too much to expect that they will attend to the history of philosophy. More is the pity because if they did then perhaps they would not repeat the mistakes philosophers have long drawn attention to.

One of the problems with constructivism, at least in the New Zealand version informing the science curriculum, is the lack of conceptual clarity of many of the key ideas and expressions. Matthews rightly complains that the notion of *making sense* insofar as this was early on take to mean *making sense to the child,* is seriously defective. There is an ambiguity with the expression: it can mean either (1) given a child's present state of understanding, what is learned makes sense because it coheres with prior learning or (2) what initially didn't make sense because it failed to

cohere with prior learning, now makes sense because there has been some revision of the child's conceptual scheme to incorporate the newly acquired scientific learning. The first meaning does not make much sense in science education but the second meaning does. The problem for constructivism is that it readily accommodates the first meaning but not the second since it offers no explanation of how this is possible.

The other difficulty constructivists often find themselves in concerns the problem of truth. Matthews correctly notes that the notion of truth rarely, if ever, gets mentioned in either constructivist writings or in curriculum documents. To be sure, we can avoid using the word *truth* but it is not so easy to dispense with truth. Various objections can be raised to standard accounts of correspondence, coherence and pragmatic theories of truth, probably to all theories of truth. There is one account of truth, Tarskis' semantic theory of truth, which serves science particularly well. Truth is a property of sentences, and to quote Tarskis' oft-quoted example:

> 'Snow is white' is true if and only if snow is white.

The *is true* is predicated to the sentence *Snow is white.* It is the sentence which is true or false. Truth is an ontological matter since what makes a sentence true is the way the world is, and a sentence is true or false regardless of whether anyone knows it to be so. On the other hand, our claim to know that a sentence is true is an epistemological matter, requiring a knower and some evidence to justify our claim to know. If constructivists and others drew this distinction between ontology and epistemology then some of the philosophical problems generated might be avoided. Constructivists have a lingering concern about whether the claims of science can be known to be true. This is a difficulty which appeal to the Duhem-Quine thesis of holism may help resolve. Our sprawling theoretical network consists of simple observation sentences at the periphery, grading off to highly theoretical sentences (logic, physics, ethics) at the core. Our observation sentences about physical things *(it is raining)* generally gather wide assent. The highly abstract sentences of logic and mathematics are generally held to be the least revisable. Our empirical theories, those of science in particular, anchored to the world by the observation sentences which provide their empirical content and implication from theory to observation structured by the laws of logic, are eminently revisable. No part of our global theoretical network is beyond revision, not the observation sentences, not even the laws of logic, although the latter would be the last to go. The sad fact is that so many think that we can quarantine a body of knowledge as certain and non-eliminable when none can be. We would make greater progress in science education, and in education generally, if teachers and learners understood the provisional nature of all that we claim to know.

Michael Matthews has been a lone crusader against constructivism in the New Zealand science curriculum. His book represents his most recent efforts to question the ideological hegemony which he sees influencing science education in this country. His has been a political challenge as much as a philosophical critique. Clearly, his book is provocative, as evidenced by the responses (Bell, 1995) he has provoked from those he challenged. If the participants in the debate can rise above the personal to address fundamental issues in science education then Michael Matthews' book will have contributed to the improvement of science education in this country

Reference

Bell, B. (Ed) (1995) Responses to 'Challenging New Zealand Science Education'. Hamilton: University of Waikato.

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Challenging New Zealand science education, by M. Matthews, Palmerston North, Dunmore Press, 1995.

The Preface to this book (p 12) revisits the public debate of 1993 in which Matthews argued that "the official science education establishment" had "enthusiastically" embraced a "loony doctrine". This was his description of constructivism. Dire consequences of this doctrine were asserted to be that "the national curriculum document holds that scientific thinking is anything but knowing science, anything but mastering the conceptual tools of science". *Challenging New Zealand Science Education* repeats these assertions, describes the NZ science education situation as alarming, and assails many other features of education in New Zealand, including mathematics and language teaching, and teacher education.

This review outlines, with evidence, the serious deficiencies in Matthews ' account of New Zealand science education. These can be summarised as follows:

- The book does not address relevant material freely available in the public record; preferring rather to make unsubstantiated assertions, to quote material out of context, and then to make derisory comments which serve the purpose of polemic, but which raise serious questions about scholarship.
- The author has, in his passionate attack on constructivism, been dishonest in his accounts of the published and relevant research in this field.

The review is addressed through a commentary on:

- the account of science education research in New Zealand, focussing particularly on the research of the SMTER Centre at the University of Waikato,
- the description of the New Zealand science curriculum,
- the *liberal* learning approach implied in the book,
- the accounts of other relevant research, and the debating style employed.

The SMTER centre at the University of Waikato

Challenging NZ Science Education identifies the SMER (now SMTER) Centre as the source of the *loony doctrine* of constructivism, which is responsible for the science curriculum turning away from "knowing science and mastering the conceptual tools of science". The claim that some of the SMTER Centre work is misguided and dangerous is very serious, and carries with it the responsibility to engage with this work in a scholarly manner. This responsibility has not been accepted by Matthews. Clearly the "misguided and dangerous" aspects of the work are implied when the book asserts that researchers in the Centre uncritically accept constructivism as a doctrine, when the Centre is implied to have ignored or devalued the rich and valuable understandings of the world which have been developed by science, and when its research methodology is impugned. Each of these implications is false, and the publications of the Centre demonstrate this.

The SMTER Centre - the reality

The Centre's research in the last twenty-six years has explored classroom learning in science and mathematics (and more recently technology). This research is recognised to contribute to international understanding of this very complex field. International scholars visit the University of Waikato to interact with the vigorous research group here. The work of many of these visitors features in Matthews' book. Their visits have contributed to vigorous debates about the complex world of the classroom, in which issues such as those listed on p91 of Matthews' book ("Why teach

science? Should science be compulsory and for how long? Is there a difference between education in science and training in science? Should science education serve educational, academic or social purposes?") have been explored. I would add to this list at least the following: What is the role of real world contexts in the science classroom? What is the role of cultural knowledge in science? What is learning in science? and What teacher education approaches could improve science education?

In reviewing Matthews' book it is important to address in some detail the **science** focus of the work of the Centre. A substantial collection of published theses, articles, books and reports describes a research scrutiny of the complex process of teaching and learning in the science classroom at primary and secondary levels. The research explores how to assist learners to incorporate the powerful explanatory concepts of science appropriately into their understanding of the physical, technological and biological world. This published work acknowledges that the appropriate scientific knowledge which informs our understanding needs to be plausible, intelligible, and fruitful before it will become accepted. The importance of teaching approaches, of familiar contexts for learning, and of student thinking have also been explored.

Our publication list outlines similar research into many other science topics such as electric current, oxidation and reduction, mechanics, genetics, biotechnology, photosynthesis, energy and many areas of primary science. The research reports make it clear that understanding of science was the clear focus, that science ideas were introduced and explored when they were found to be absent from the students' prior knowledge, and that the generative learning model was explored and developed rather than accepted as an unquestioned truth.

The SMTER Centre's research into the complex world of the classroom has been further enriched by considering issues of equity of access to learning, by exploring teacher development, and through scrutiny of assessment processes.

The portrayal of the SMTER Centre research in this book

Matthews describes constructivists as saying "that teaching has to be *confined* to what pupils already have some conceptions of' (original emphasis, p94). No source is given for this assertion because there is none in our research output. He also asserts that constructivism is "undermining the epistemic standing of science" (p98), "deprecating the conceptual nature of understanding" (p98), that constructivists state that "teachers do not need to know the subject matter" (p 108) and makes many other claims that we disengage from knowledge of science. The published accounts of the SMTER Centre research give the lie -to all of these false claims. The Centre's work, which explores in great detail the introduction of science knowledge to classrooms and the consequent learning of science content, is almost completely invisible in *Challenging New Zealand Science Education.* The only reference to relevant research is a grossly inaccurate account of LISP(Energy).

Matthews later states that the last two Leaming in Science projects have wasted public money (p 131-132). A reference to the third LISP(Energy) study begins:

> In standard Waikato research the flattering self-absorbed attention paid to each individual's smallest thoughts and feelings would lead to a Hawthorne Effect on a scale undreamt by those conducting boring old-fashioned social science or educational research. (p 130)

The justification for this assertion is a single paragraph from a paper on the professional growth of the teachers involved in the research, which was a side effect of the main research (Carr and Kirkwood, 1988). The contract research questions are clearly stated in the Final Report of the project (Kirkwood and Carr, 1989). They address issues related to the curriculum, to understanding of the scientific view of energy, and to the impact of an alternative instructional strategy in the classroom. The research methodology used to investigate these research questions is a mix of qualitative and quantitative procedures. Matthews *discussion*- of LISP(Energy) ignores the research questions and

the published findings of the research (twelve Working Papers, a Teacher's Guide, an unpublished thesis, and seven reviewed journal articles).

Matthews' account of the New Zealand science curriculum

Matthews' image of the curriculum focuses on a view that the curriculum "is remarkable for its neglect of the conceptual structure 'bf science", and that this is "another outcome of the constructivist focus on the learner". This "is something that naturally follows when *making sense of* is substituted for *learning about* in the aims of the curriculum". (p155-156)

Rather than ignoring knowledge, the first aim for science education in *Science in the National Curriculum* is clearly stated to be "helping students *to develop knowledge and a coherent understanding* of the living, physical, material, and technological components of their environment" (p9). The curriculum states at the beginning that "Science is both a process of inquiry and a *body of knowledge;* it is an integrated discipline. The development of scientific skills and attitudes is inextricably linked to the *development of ideas in science"* (p14). The document stresses knowledge when each learning strand requires that "In their study of' each particular section of the curriculum "students will use their *developing scientific knowledge,* skills, and attitudes to" ... investigate, apply their knowledge, establish scientific concepts, and to research ideas and activities fundamental to science. (The emphases in this paragraph are made by the reviewer).

Perhaps because it would undermine the absurd quotation above, Matthews' account makes no reference to four documents: the senior subject curricula *Biology in the New Zealand Curriculum, Chemistry in the New Zealand Curriculum,* and *Physics in the New Zealand Curriculum,* and *Te Tauaki Marautanga Putaiao* which is a parallel science curriculum in Maori. These are all part of the science curriculum. The first three contain many pages of statements about science content appropriate to New Zealand classrooms.

In sharp contrast to Matthews' assertions, the approach recommended in the science curriculum encourages engagement with, and development of, the concepts of science by declaring ideas, scrutinising them in relation to alternatives, and building new understandings using appropriately the powerful ideas of science. To link this approach with anti-scientific tendencies and superstition is to move beyond reasonable debate to offensive and mischievous misinterpretation. This was pointed out to the author in 1993, yet he continues to write about the curriculum in this ridiculous manner.

Making Sense

The comments about *making sense* in *Challenging NZ Science Education* are a misreading of the curriculum. This has been explained to the author on many occasions, yet he continues to ignore the explanations. The science curriculum acknowledges the difficulty many students have in accepting the explanatory power of science concepts in interacting with their world. This process is what is meant by *making sense.* (The use of this phrase links to the familiar primary science handbook *Making Sense of our World,* Biddulph and Osborne, 1984). The curriculum documents provide the basis through which new scientific knowledge can be explored for intelligibility, plausibility and fruitfulness, or for correspondence to the world of the learner. This making sense sometimes means changing firmly held *common sense* ideas about the world. When educators want to help students to accept that the earth rotates (to take one of Matthews' examples which *literally defied sense)* they do so on the basis of links to features of our experience, such as the movement of the stars across the sky, and the regularity of night and day. If teachers cannot help students to make sense of a concept in science, in this meaning of the phrase, then their students will not be motivated to *explore and develop their scientific knowledge.* This is the defined task of the new science curriculum. The curriculum view of science education accepts that science is often

not *common sense,* and provides the opportunity for teachers to deal with this problem. Matthews' continued endorsement of the statement that "if it makes sense it is probably not scientific"(p82), is an idiosyncratic contribution to science curriculum development which he does not explore in any coherent manner. When a concept in science does not "correspond with their world" are learners to be told to trust the authority which knows best? Matthews makes an emotive and confused link between the New Zealand science curriculum and social evils such as Nazism. The irony is that his *rejection* of making sense would appeal to the architects of totalitarian political systems.

Matthews persistence in applying his term sensism (p82) to New Zealand constructivists flies in the face of repeated clarifications. He uses other labels such as relativist (p67), empiricist (p66), solipsist (p82), instrumentalist (p 119), and subjectivist (p82) without defining them or indicating in what manner they apply to New Zealand and other constructivists. They apply to his fantasy and have nothing to do with the curriculum documents.

The status of truth

Matthews' book makes much of the avoidance of the word truth in the curriculum. This he takes to demonstrate a lack of clarity about, and a disengagement from, scientific knowledge. His argument in this area is a pyrotechnic display based on the view that avoiding the word truth is a clear signal that relativism and other evils have been affirmed. This, he asserts, will have dire consequences for science education and for society, resulting in unacceptable social beliefs.

He sets up a nonsensical and frightening image through unsubstantiated assertion and quotations out of context, ignores the evidence which challenges his image, and then thunders about alarming consequences. The reality is simpler and less apocalyptic. The issue of truth is a major problem for science education. What truth about a concept such as the atom, energy, force, photosynthesis and the whole gamut of powerful concepts in science should teachers provide at each level of schooling from new entry to form 7? Is this truth unvarying? The answer is clearly that a concept such as the atom will need to be continually revisited and refined. If one starts by quite reasonably describing atoms as the smallest unbreakable bits of matter it is unwise to confer the status of truth on this idea. Later in their learning students will need to engage with ions and subatomic particles. Later still with isotopes. Later again the mass-energy duality will be faced. The reason why the Policy Advisory Group described truth *as a very slippery concept* hinges on precisely the difficulty of stating partially-developed scientific ideas as truths. Classroom teachers and researchers are very familiar with the frustration and confusion expressed by students about what they see as the delivery of *right answers* which require frequent revision. The use of the phrase *making sense* and the avoidance of the word truth acknowledges that learning in science is a process of continuous conceptual development.

Other difficulties with Matthews' account

This review cannot address all the confusions about the curriculum in *Challenging NZ Science Education.* Matthews' commentary makes no distinction between a curriculum and a prescription, and he misinterprets the curriculum statements about girls and science, and Maori and science. The learning strand *Making sense of the nature of science and its relationship to technology* addresses the history and philosophy of science at a level the curriculum writers and the Policy Advisory Group judged to be appropriate to school science education. This focus of much of Matthews' alternative *liberal education* is ignored. He describes eighteen pages of *Science in the New Zealand Curriculum* as follows:

> comments about history and philosophy were throw-away lines: they were, at best, a Reader's Digest level. (p164)

A scholar faced with a detailed proposal which covers 18 pages, and is so close to his interest, would surely engage with it. His refusal to do so suggests that his false portrayal of the curriculum would not survive the resulting scrutiny.

The liberal approach to science teaching outlined in the book

The importance of prior knowledge

Matthews has a firm opinion about students' prior knowledge:

> Further, and more importantly, constructivists constantly say that teaching has to be *confined* to what pupils already have some conceptions of Teachers are told to ascertain student ideas and build upon them, without this foundation it is maintained that there cannot be effective teaching. This is sensible in fields where students have some ideas, but in many cases students do not have ideas. (original emphasis)

Later on the same page

> students will know nothing about electrons or atoms; they will have no opinions about tectonic plates; they will have no conceptions, mis- or otherwise, about gravitational attraction . (p94)

The quote contains a significant implication for teaching. Matthews' confident assertion that students will know nothing of a number of science concepts (the list expands in other sections of his book) ignores a copious literature about learner's ideas to do with electrons, atoms, gravity and many other science concepts, for example, the bibliographies by Pfundt and Duit (1994). Matthews appears to be ignorant of the common alternative conception that gravitational attraction is associated with the earth 's atmosphere, which is the reason for many students believing that there is no gravity on the moon, Stead and Osborne(1981). Teachers would also be wise to find out what a class knows about tectonic plates, since this theory frequently features in popular TV programmes about earthquakes (the book laments that NZ students spend so much time watching TV on the very next page).

Matthews ' refusal to engage with the prior ideas of children results in a curious and unpleasant statement:

> Constructivists in New Zealand are moving from the implausible personal constructivism that many originally held - wherein feral children could presumably generate science -to social constructivism. (p123)

I know of no other colleague who would refer to children as feral, no matter what the debating purpose. I have sat fascinated in classes where 5 and 6 year-olds debated whether they should describe a cork as floating and sinking when part of it was above and part under water. They came to agree that they should think about the cork as a whole (Carr et. al., 1991). My admiration for the kind of thinking these very young children can do appears to be very distant from Matthews' characterisation of young students.

Science and culture

My concern with Matthews' contribution to the complex area of cultural contexts and science education centres on two statements:

> the constructivist stress on questioning, on problematising the subject matter as it is known, is a culturally specific educational injunction. It can be deleterious to education, to say nothing of being politically incorrect, when generalised from middle-class cultures to others. (p99)

and when discussing, on p 146, how "political correctness demands that we give [Maori knowledge labelled as science] equality with Western science".

> Why people feel driven to assert equality of achievement between cultures is itself interesting. It seems more sensible to say that some cultures do some things well and other cultures do other things well. European Jewry has had (but only since the mid-1800s) terrific success in fostering scientific talent, but it clearly has had no success in fostering sporting talent. The Hmong people of South-East Asia have wonderful handcrafts but little achievement in technical areas... Some cultures have outstanding musical traditions, while other cultures barely rise above noise production. (p215)

Matthews' evidence for the first statement is: "Many children and many cultures learn quite well without obvious questioning". I imagine this is the case for nearly all traditional societies. My many interactions with science educators from many cultures does not support this unresearched rejection of procedures which question and problematise students ' *development of conceptual understanding.* Whilst these educators acknowledge the difficulty of this approach in some cultures, they are clear about the value of continuing to seek ways of enriching science education through probing student understanding and engaging them in problem-solving.

There is no statement about the *equality* of Maori knowledge with science to be found in the New Zealand science curriculum documents. This false assertion is the basis of an extended and derisory attack. The curriculum documents contain clear suggestions about engaging with Maori prior understandings as *entry points for learning science.* The cultural arrogance displayed in Matthews' footnote has alarming implications for classroom teaching. Are we to look at students, classify them as Jewish, Hmong, Maori etc, and then decide *on the basis of their appearance* their capabilities in sporting activities, in technology, or in music? Matthews' book is full of attacks on New Zealand science educators for opening the doors to societal evils. The implications which flow from it appal me.

The place of history and philosophy in the curriculum

The book devotes Chapters 7 and 8 to the liberal approach, with an emphasis on history and philosophy. Chapter 7 is an account of pendulum motion and air pressure which outlines the difficulties which students have in developing their understanding from their experience of the world to our current scientific understanding. This is precisely the concern of the New Zealand science curriculum. Chapter 8 describes the inclusion of history and philosophy of science into science education, and focuses on the need for teacher education to include these dimensions.

There is some important and interesting material in these chapters. The account in Chapter 7 is however marred by attacks on science educators described correctly as constructivists, but associated with views they do not hold. Of particular interest is reference to the Waikato chapter in the book *The Content of Science: A Constructivist Approach to its Teaching and Learning* (Fensham et. al., 1984: 147). The preface to this 14 page chapter states:

> We argue here that open discussion of the 'rules of the game' of science would contribute to better learning in the classroom, since learners would be better equipped to change their existing concepts by knowing more about the nature of science itself.

Matthews argument is remarkably similar. The Waikato chapter is dismissed in Matthews' book with a quote out of context (p81), and the footnote "The contributions to the Monash (1992) and King's College (1992) seminars are not encouraging." (p219) My explanation for this refusal to address the Waikato work is that to do so would spoil the false argument that constructivists do not address the history and philosophy of science.

Chapter 8 discusses the importance of the history and philosophy of science to science teaching and learning. That is, of course, why the new science curriculum contains the section *Making sense of the nature of science and its relationship to technology.* An early statement of a similar position comes in a paper by a New Zealand educator (Fletcher, 1979) which is frequently cited and discussed in our science education debates. Matthews does not cite this relevant paper.

Chapter 8 is marred by the assertion that in New Zealand "an appreciation of the nature of science is simply not developed in teacher training programmes", (p 196). The Waikato and Auckland programmes have this dimension of the nature of science as a major focus.

Summary: Teachers reading Matthews' book are provided with a misinterpretation of constructivist teaching and learning approaches, and exhorted to reject them in favour of the liberal teaching approach. The liberal approach described in this book casts aside the importance of prior knowledge, rejects the exploration of understanding through questions and problem-solving, and invites teachers to make racist judgements about the capabilities of their students. It is falsely asserted to be the only of the two alternatives to engage with the history and philosophy of science. Matthews is irresponsible when he rejects a carefully-researched approach and leaves teachers with a potentially dangerous muddle as an alternative.

The accounts of other relevant research, and the debating style employed in Matthews' book

Throughout *Challenging NZ Science Education* the author is dishonest in his description of published research. He misrepresents the writers' work, quotes out of context, and derides the researchers. This review has already noted the inaccurate account of the SMTER Centre research in (1) above. This section addresses his discussion of four chapters in *The Content of Science: A Constructivist Approach to its Teaching and Learning,* (Fensham et. al., 1994). The subject matter of this book is apparent from its title. The book, through eighteen Chapters from international scholars, engages directly with, and refutes, Matthews' claims that constructivism "undermines scientific know ledge claims", and deprecates "the conceptual nature of understanding" (p 16). These Australian teachers go on to clearly state that they do not mean that *any old thing will do,* and they outline the need to expand their students' knowledge by leading them into areas outside their experience. Matthews dismisses their work as a statement that "ignorance is bliss". Matthews' ridiculous image of hard constructivism has no connection to the constructivist classroom practice of these teachers.

The nature of the debate in the book

It is difficult to write about this book. So much of it is boorish, inaccurate, ill-informed and muddled that a detailed critique must look like a desire to stifle legitimate debate. This is far from the intention of this review. Important matters to do with science education have been debated within New Zealand and internationally for a long time. The feature of Matthews' book which makes it so problematic as a contribution to reasoned debate is his mispresentation of the work of constructivist science educators, and the unpleasant style of his argument. He sets up false descriptions of constructivist science education, ignores or misrepresents material which does not suit his false description, and derides those who do not share his views. I find the bruising nature of his references to the work of respected colleagues indefensible. When a colleague makes scornful comment such as those about Merlin Wittrock (p86) and Rosalind Driver (p 105) and many others the professed *liberal approach* is promoted in a discourse which is shameful.

An excuse for the unpleasant vigour of his attacks might be that they are based on careful scholarship. This is not the case, rather the book has a careless attitude to evidence. This is now explored.

Matthews' research methodology

(1) The frequent use of anecdotes and unfocussed comment.

Consider the following statement, typical of many throughout the book:

> During my two-year period in Auckland I met numerous good and enthusiastic teachers who despaired of the teacher development courses which they attended. Many walked out, others endured to the end but said their precious time and school money were wasted. (p217)

My questions as an assessor of this *research* would be:

- How many is *numerous,* what is meant by *many?*
- What was the nature of the teacher development courses referred to?
- Were the teacher development courses *relevant* to Matthews' context of an assault on process-consumed New Zealand teacher development programmes (p134)?

(2) The validity of the research probes employed

The book devotes Chapter 2 to a wider

> debate about the purpose of education and about the maintenance educational standards (sic) in literacy, numeracy and reasoning. (p44)

Matthews gives details of a diagnostic test given to Auckland primary teacher intakes, and uses these to conclude that

> This particular result reveals a massive failure of mathematics education in New Zealand schools. (p61)

Scholars in the field of alternative framework research are cautious in their conclusions from similar probes of understanding, for very good reason. In a survey graduating students at Harvard University (including science graduates) were asked why it was warmer in the summer than the winter. The overwhelming response was that *the earth is closer to the sun in the summer.* The researchers did not attack the quality of the Harvard science programmes, or the science knowledge in general of the graduating students. Harvard is after all one of the great universities in the United States. Their conclusion was that many unexpected prior ideas escape modification during instruction. A scholarly survey of the state of mathematics education in New Zealand would refer to detailed analyses such as the results from the International Association for the Evaluation of Educational Achievement (Department of Education, Wellington, 1987). The report concludes that New Zealand seventh formers achieve well and compare favourably with their international counterparts.

(3) The accuracy of quotations

Qualitative research requires that quotations are correctly ascribed, and triangulated for accuracy and balance. Matthews devotes pages 31 to 36 to the 1989 debate on the *Draft Forms 1-5 Science Syllabus.* Fifteen quotes are used in evidence. The first quote is incorrectly ascribed to the government. It comes from the Ministerial Task Group of which I was a member. Nine quotes are incorrectly stated to be from the Education Committee of the Royal Society of New Zealand, presumably to give them status. Matthews precedes each quote with phrases such as "the Royal Society said" and "the Society believed". These quotes are the personal opinion of a member of the Royal Society Education Standing Committee about an early draft of the syllabus, misleadingly referenced on p246. I was a member of the Education Committee at this time. When we considered the Draft Syllabus we did not accept as our view the opinion quoted by Matthews at such length. The Convenor wrote a submission which indicated that "the Committee did not feel that it could return a response that could claim to represent the views of NZ scientists, or even of those who are Fellows of the Society" (Vere-Jones, 1989). Another quote incorrectly asserts that members of the syllabus Advisory Committee were "denied access to the actual returns" from public responses. I was a member of this group also, and I read these submissions to the draft syllabus when they were made available at a regular meeting.

This is a startling error rate, eleven of fifteen statements are wrongly ascribed or incorrect.

Conclusion

This review of *Challenging NZ Science Education* focuses on areas of the book which the reviewer knows a good deal about, arguing on the basis of this detailed knowledge that the book is inaccurate and misleading. This highly-charged challenge, written by an academic who spent two years in New Zealand, has not engaged in a scholarly manner with the science education which he so carelessly assails. Other writers, in the SMTER Centre and elsewhere, are equally concerned about the accuracy of those sections of the book which lie within their areas of expertise.

There are challenges to be made of NZ science education. This reviewer would begin with noting the challenge of a science curriculum which provides, for the first time, opportunity to develop an integrated science programme through to the end of Form 7. Another challenge is to critically evaluate the progression in the development of scientific knowledge implied in the new curriculum. These and other challenges are ignored or lost in the rhetoric of Matthews' inaccurate description of New Zealand science education.

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