The cultures of Science Education across the World

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Volume 1: Handbook of Research in North America. Wolff-Michael Roth & Ken Tobin (Eds) 2009. pp. 699 ISBN 978-90-8790-745-7 paperback USD69/EUR65

Volume 2: Handbook of Research in Australasia. Stephen M. Ritchie (Ed.) 2009. pp. 308. ISBN 978-90-8790-927-7 paperback USD49/EUR45

Volume 3: Arab States. Saouma BouJaoude and Zoubeida R. Dagher (Eds.) 2010. pp.292. ISBN 978-94-6091-045-6 paperback USD49/EUR45

Volume 4: Handbook of Research in Science Education Research in Asia. Yew Jin Lee (Ed). 2010. pp.446 ISBN 978-94-6091-072-2 paperback USD49/EUR45

The World of Science Education is an ambitious seven volume series being published by Sense Publishers. The series editors are Ken Tobin and Wolff-Michael Roth, and each individual volume is edited by one or more regional experts. Four volumes were available at the time of the review, covering North America; Australasia; the Arab States; and Asia. In this review I will refer to the volumes by these regions. Further volumes are planned covering South and Latin America; Sub-Saharan Africa; and Europe with Israel.

The titles of (three of) the individual volumes announce them as handbooks in science education. There has been a sequence of publications of this type (Abell & Lederman, 2007; Fraser & Tobin, 1998; Gabel, 1994) and another option in this market may seem to be superfluous relatively soon after the Abell and Lederman volume. However, the clue to the logic of this new venture is the thematic title of 'Cultural Perspectives in Science Education' - for this World of Science Education is seen as a multi-cultural World deserving of a set of handbooks reflecting cultural diversity. Any exploration of whether the volumes reviewed here meet this criterion should be informed by the

reasons for considering that the specifics of culture(s) should be relevant to science education. The series editors' argument in their introduction is that

> there are regional differences within science education that could be interesting but generally are obliterated in a hegemonic hogwash of the generality and context-independence of scientific knowledge. Regional differences concerning certain questions, such as the ongoing debate about religion and science - creationism and intelligent design versus evolution - are non-starters in most if not all European countries.
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> (Roth & Tobin, North America, p.2)

This may be true, but it would not be the case in some of the Arab States: for the reader is told by BouJaoude, Abd-el-Khalie and El-Hage that University biology professors in Lebanon spanned "the full range from literal creationism to the acceptance of materialistic evolution" (Arab Sates, p.229). In Islam, as Nasser Mansour points out in his chapter on religion and science education in Egypt, "the study of nature is not for its own sake; rather it is supposed to serve as a means of bringing one closer to God" (Arab States, p.109). This reflects a view that was common among Christian scientists of centuries past, but which is antithetical to some high profile materialist Western scientists today (Cray, Dawkins, & Collins, 2006). However, chapters in the Arab States volume point out that in contexts such as Jordan and Oman it is considered quite appropriate to include statements about how the study of the science curriculum should strengthen students faith among the explicit aims of the school science curriculum. Despite this, El-Amine notes in his chapter that "there are limited efforts in the Arab region to investigate how science and religion (more specifically Islam), influence science education and student thinking about science" (Arab States, p. 262). The interaction between Worldviews deriving from different world religions and the understanding of science education is one area that could have been explored in more contexts within the different volumes.

In relation to the series editors' general concerns about the danger of 'hegemonic hogwash', it is clear that different contributions reflect regional or national concerns to different degrees. So contributions (by Bencze and Alsop; and by Alsop and Bowen) exploring the nature of enquiry in science education in the North American volume will certainly be of some interest outside that region, but without seeming as central to debates about science education as they will be to those working in that region, where enquiry teaching is "not only widely used but is fervently advocated by research and policy in the US" (North America, p.50). By comparison, Aubusson, Treagust and Harrison's chapter about teaching and learning with analogies and metaphors is surely relevant globally, and is situated in the Australian volume simply because of the major contributions to the topic from science educators in that region.

Certainly these volumes are timely in one respect. It has been recognised that, as a field, science education has moved through a series of phases (Erickson, 2000; Fensham, 2004; J. K. Gilbert, 1995), and in recent years there has been an increased focus on aspects of the study of cultural issues.

Indeed the recent founding of a journal specifically for publishing 'Cultural Studies on Science Education' (with the editors of the reviewed book series as its founding editors, Roth & Tobin, 2006) is not just coincidental to the arrival of the present series, but clearly an outcome of the same imperative within parts of the science education research community.

However, a number of different threads might be seen to be entangled here. One of these relates to a shift from personal constructivist to social constructivist and constructionist perspectives when exploring student understanding and thinking in science learning. This might be characterised as a shift from seeing Piaget (and in some quarters Kelly) as providing the starting point for thinking about student learning in science, to seeing Vygotsky as the key theorist for informing ideas about learning and teaching in science (Taber, 2009, pp. 191-199) - something explored in the opening chapter of the North America volume contributed by Regina Smardon. That, however, is only a partial explanation - as for all his focus on socio-historical context, Vygotsky did not shift the locus of learning from the individual mind in the way some contemporary social constructivists have. For example, Vygotsky's notions of spontaneous concepts and the zone of proximal development (Vygotsky, 1934/1986), are primarily about individual cognition; albeit cognition that will come to be structured through interaction with others. Smardon argues for the value of activity theory, built upon and developed from, but arguably having a different emphasis to Vygotsky's own work.

However, this perspective is largely limited to informing writing in the first volume, from North America (and even then many of the contributions to that volume do not draw upon such a perspective to any obvious degree). Although the opening chapter sets up the series by offering 'Socio-cultural and cultural-historical frameworks for science education' (pp.15-25), these frameworks are at best implicit in, and in truth often ignored in, many of the other contributions. In a chapter in the North American volume about methodology Wolff-Michael Roth uses the example of a report of a boy who physically fought with his father, and was expelled from schools because of his behaviour. Roth (North America, p.122) reports how "both father and son made each other responsible for the situation until, through critical consciousness raising during counselling sessions, both realized that the source of the problems they both faced derived from the historical condition of the working class". Such an analysis sat well in *this* Chapter (and offers an interesting counterpoint to the consideration of caste in Upadhyay, Regmi and Sharma's Chapter in the Asian volume), but would have appeared very incongruous in many of the other contributions to these books. This surely reflects a key issue in any enterprise that claims to reflect and celebrate diversity: that such a stance may be inconsistent with setting out a coherent intellectual programme to guide the overall writing project. Perhaps this is a not a problem, but simply an inevitable characteristic of such a collection: the perspective that informs the rationale and basis for setting up the project by its very nature requires different contributors to offer their own agenda in the areas they review. (There is perhaps a parallel here with the situation of an advocate of free speech who has to decide whether to support the right to free speech of an activist seeking to deny certain minority groups a voice. Luckily the issues for the present editors are less serious than faced by my hypothetical liberal.)

The shift towards a focus on culture within studies in science education derives not from psychological work, but from the sociological turn in science studies. Here Kuhn (1996) has been massively influential, having redirected much thought about the nature of science from philosophical considerations of how science should work (à la Popper) to a sociological analysis of what does happen in science. A prescriptive model might tell us when we should refute, but a sociological analysis explores better how scientific ideas have not always triumphed or fallen when the philosophers' models might have indicated they should (Taber, 2009, pp. 79-89). This leads to a focus on ideas about how scientists are actually inducted into the community (Roth & Bowen, 1995), drawing for example on legitimate peripheral participation (Lave & Wenger, 1991); and on how scientists use rhetorical and other devices to push for their favorite ideas - and to explain away the opposing views of other scientists who have reached contrary conclusions (G. N. Gilbert & Mulkay, 1984). This theme can be seen in some of the work here considering the science classroom as about socialisation and enculturation into a form of practice - often with an emphasis on the 'discourse' of that community. In their chapter, Alsop and Bowen (North America, p.53), whilst arguing that such a perspective should not obscure concern with individual personal growth, acknowledge how "an overwhelming emphasis (in research and practice) is put on induction and initiation into a subculture and its associated epistemology - the language, culture and tradition of science". This type of approach is reflected, for example, in a chapter by Bratton & Gilmer in the North America volume, set in the context of undergraduate biochemistry education.

Another, somewhat different, perspective has derived from considering science itself as culturally grounded (and so at least somewhat contingent upon the culture that it emerges from) and therefore considering how access to science education may be experienced differently by various cultural groups. One clear example is studies of gender and science that argue that 'science' as currently generally understood is inherently masculine in certain ways. This can be understood on at least two levels. If science is presented in 'masculine' ways, this may make it less relevant, less attractive and less comprehendible to female learners. For example, if girls find the idea of 'relating to' nature as engaging, but the discourse of science education presents science as about 'taking apart' and 'controlling' nature, then the subject may appeal more to boys (Bentley & Watts, 1987). At a more fundamental level, some have argued that the problem goes well beyond presentation, as our understandings of what science is, and how it may be practiced, are stamped with centuries of male domination. The argument here is that those people 'doing gender' as females may have different cultural resources, and so less access to a science constructed from a male mind-set. The North America volume includes a subsection considering 'equity in science education' and including a contribution (by Angela Calabrese Barton) on feminist work in science education as well as a chapter (by Jovanovic and Bhanot) looking at gender differences in science. The gender theme is not given such a high profile, however, in the other volumes reviewed. This left one wondering if gender should be a more explicit focus, for example of the volumes on the Arab States?

As well as being seen as male, science (or at least the currently dominant understanding of science) has been considered to be a 'Western' phenomena, having developed largely in Europe, albeit with strong influences from the Arab world and beyond. Debates have again developed both around how science itself might be influenced by a particular culturally derived mindset, and how it may be less accessible to learners from indigenous populations. In many traditional cultures, distinctions between science, technology and spiritual domains are not clearly drawn as they often are in the Western mindset with its analytical (ruler than holistic) tradition of doing science. Obviously there is a core issue here: to what extent is the success of modern science linked to the predominant ways of thinking of Western scientists (and those who have adopted their mindset) over the past, say, three centuries - and to what extent is science as commonly characterised simply historically contingent upon the success of Western European nations in dominating much of the world, and often taking advantage of the peoples from other cultures? It seems clear enough that science undertaken from the Western worldview has made good progress in many areas; but it is impossible to know how science would have proceeded in a world with a very different history - say if Asian nations had built global empires in the eighteenth and nineteenth centuries and subjugated Western European nations in the process. Would science have made less; or more; or just different; progress? Would it have evolved the same 'nature' - or perhaps come to be understood very differently? It is easy to think that science has developed the way it is because that is the best path for scientific progress, and indeed that science is actually outside of culture - somehow neutral about and above it, culture-blind - but the only science we know is a human construction, and - as Geertz (1973) suggested - the notion of being human whilst existing outside of some particular culture is an oxymoron.

This clearly leads to considering whether some groups of learners, from particular cultural backgrounds, are in some sense excluded from a full participation in science education because (a) school science does not reflect how science would best be understood in their communities; and (b) because they bring different cultural resources to class, resources which are less appropriate to provide access to school science than those available to other cultural groups. Both the North American and the Australasian volumes include contributions considering science education among indigenous populations in those regions. Whilst this topic does not have such a high visibility in the two other volumes reviewed, relevant material can be found in particular contributions - such as the chapter by Tapan set in Bangladesh in the Asian volume. The North American volume also has contributions focusing on other population groups, reflecting the significant populations in the US in particular, arriving from Central and South America, and Asia, or being of African descent.

A slightly different question concerns the learning of science. Regardless of whether we accept the cultural relativity of the nature of science, and the socio-historical contingency of its productions (theories, models etc), there is clearly a question of whether culture channels the learning of the science (or perhaps more correctly, of the representations of science) prescribed in a curriculum. Firstly, we might ask to what extent curricula reflect 'local' conditions, rather than globally recognised concerns. Secondly, we might wish to know whether there are cultural differences in how learners engage with, and come to understand, science concepts and topics. One area of

interest here relates to learning difficulties in science. A strong theme in science education has been understanding learners' ideas and thinking in science topics, to appreciate the nature of their learning difficulties, and so to inform pedagogy. It seem likely that studying cultural variation in this area - for example differences in the commonality of alternative conceptions found in different educational settings - can contribute to the research programme into teaching and learning in science (Taber, 2009, pp. 349-351). This point is probably actually reinforced from the socio-cultural perspective where, as Hsu (North America, p.239) argues, "from the discourse perspective, students' (mis)conceptions are not actually students' (mis)conceptions in their minds but are generated in that particular discourse, contributed by all kinds of components such as tools, interviews, and activities".

There is relatively little explicit exploration of this question in these volumes: however the Asian and Arab States volumes do review some of the work on exploring learners' ideas and alternative conceptions in particular national contexts. So, for example, in the chapter reviewing science education in Jordan (by Al-Muhtaseb & Al-Weher) the reader is told there have been studies which showed that 'creative problem solving and constructivist learning' had been effective in developing student metacognition, and that a 'constructivist learning strategy' improved students' achievement, understanding, skills and attitudes (Arab States, p.162). It is reassuring to know that approaches found successful in other educational contexts work in Jordan, but without a theoretical motivation for suspecting matters would be otherwise, or a detailed analysis of precisely how these approaches interact with cultural features, then such reviews offer little insight into the socio-cultural basis of science learning. Relevant variables could include features of language; of norms relating to attitudes to authority; of expectations about appropriate teacher/student behaviours; or even just of specific features of the curriculum - such as when and in what sequence, and at what level of treatment, students meet science topics. As the series editors noted (as quoted above), regional differences "could be interesting but generally are obliterated in a hegemonic hogwash of the generality and context-independence of scientific knowledge".

Reflecting the tensions discussed earlier in this review, a strong impression given by the volumes is of the lack of unity in style and core concerns across the volumes. The North American volume (despite representing just two national contexts) is much thicker than the others, and is in some ways the most challenging in terms of promoting an agenda. It is here where socio-cultural ideas have most clearly been adopted in framing at least some of the chapters. Within one contribution in the Asian volume (by Sungwon Hwang and Wolff-Michael Roth, and so including a North American author!) that does seek to adopt a 'cultural-historical and dialectical approach', it is acknowledged that such ideas have not yet been widely influential in that region.

It is also clear that there is a sense that the first volume can largely be about a region as a whole (being in effect the US and Canada), so there is no strong attempt to highlight within-region differences. The Australasian volume, is quite similar in that regard (being again dominated by work in two countries that have strong links and much interchange of people and ideas), whereas the other two volumes reviewed each report on a range of countries with quite different cultural

features. The Asian volume is somewhat hybrid in its approach, with many chapters having a thematic basis, but located within a particular national case study; whereas many of the contributions relating to the Arab States set out to offer an overview of science education within a particular national context. Unlike the other volumes, the Arab States volume does not include an index, which is unfortunate, as this will reduce its value as a resource for scholars. The need to squeeze so many contexts into the Arab States and Asian volumes inevitably effects thematic coverage. So, for example, while the North American volume includes a chapter by Edmund Marek describing the evolution of ideas about the learning cycle, the Asian volume does not include a comparable account of lesson study in Japan. This omission occurs despite the volume editor noting how this approach has "now migrated into new cultural settings unimagined by its founders at the same time as the envelope is altering for what is canonical Lesson Study" (Asia, p.3). Surely here there was an excellent subject for exploring how an approach to studying science teaching developed in a particular cultural context becomes modified as it is adopted in, and adapted to, local conditions in different educational systems.

Ultimately, a project such as this must be judged in terms of the value its component parts. In this respect there are a number of different types of contribution here that readers will value:

- those which set out to develop themes within a sociocultural framework, to give examples of the contribution of this perspective to progressing science education;
- those which reviewed major areas of work within science education which are of interest to those of us working in the field;
- those which offered a brief overview of the features of science education in specific national contexts.

In some ways, these different types of chapter do not always seem to belong together, especially as some are highly theoretical, and other largely descriptive. A more coherent collection might have been obtained had the contributions in the latter two categories more explicitly drawn upon the framework being championed in the first category.

Despite this diversity in style and purpose across the volumes and their component chapters, the different contributions do all offer something useful to the reader. The thematic reviews are often quite similar in nature to those in other science education handbooks, but the other two types of contribution are certainly adding something new to those existing resources. As a reference work for academics and students, then, the World of Science Education will prove to be of considerable value, and will earn its place on Library shelves.

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