Eurasia Journal of Mathematics, Science & Technology Education, 2007, 3(2), 163-166

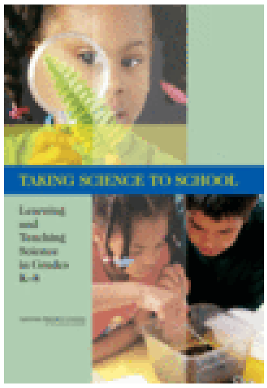
www.ejmste.com

Book Reviews

Mehmet Fatih TAŞAR, Section Editor
Gazi Üniversitesi, Ankara, TURKEY

TAKING SCIENCE TO SCHOOL: LEARNING AND TEACHING SCIENCE IN GRADES K-8

by Richard A. Duschl, Heidi A. Schweingruber, Andrew W. Shouse (Editors)
2007
National Academic Press, Washington, D.C.
404 pp.
ISBN-10: 0-309-10205-7
ISBN-13: 978-0-309-10205-6 (hardback)



This extensive monograph, now published as a book (but also available in individual chapters from http://books.nap.edu/catalog.php?record_id=11625) is a product of the work of the Board on Science Education of the US National Academies of Sciences. As an institution, this group has long taken an interest in the role of science education and commissioned these authors and their collaborators to produce a consensus report about what is known about teaching science to young children (age 14 or less) from the research that has been conducted in psychology, science education and other domains. The work of the committee was conducted through a series of meetings with extensive collaboration in between. The result is a very comprehensive review of what is currently known about the eponymous issue flagged in the title.

Some might ask what does this add to recent publications such as 'How People Learn' (Bransford, Brown, & Cocking, 2000) and 'How Students Learn Science' (Donovan & Bransford, 2005) which are both written from a psychological perspective. Or in the case of science, the extensive handbook summarising many years of research recently published and edited by Sandy Abell and Norm Lederman (Abell & Lederman, 2007). The answer is quite straightforward. This book represents a synthesis of research that has been conducted in both domains that examines not only what is known but what are its implications. No one book can attempt to capture all of the research that might be germane to any issue. Nevertheless, this book does manage to capture a lot of our current understanding in a lucid and clearly written form. Indeed, such is the depth and breadth of this report that it will stand as an authoritative statement against which others will be measured for a long time.

Why does it succeed where others have failed and where does it fall down? To turn to the first of these questions. The book begins by sketching out the path that science education has travelled, based in the belief that it helps to know how we got to where we are today and, also, that there is something to be learnt from both the successes and the mistakes of the past. This bit is brief though and others have attempted such work in much greater detail (DeBoer, 1991). This is not a criticism as its main function is to introduce the brief given to the committee which can be summarised as six questions:

1. What does research on learning, culling from a variety of research fields, suggest about how science is learned?
2. What, if any, are the critical stages in children's development of scientific concepts?
3. Where might connections between lines of research need to be made?

ISSN: 1305-8223

4. Given a comprehensive review of research, how does it help to clarify how to teach science in K-8 classrooms?
5. How can this existing body of research be made useful for science educators and others?
6. What other lines of research need to be pursued to make our understanding about how students more complete?

Thus the book must be measured by the extent to which the report achieves these goals. Inevitably, given such a brief some answers were going to be addressed more systematically than others. In particular, perhaps, the answers to questions 1, 2 and 5. This is where the report is strong – particularly in the range of evidence that it draws to support its case. Readers will find that this is one of the most comprehensive reviews ever undertaken about how science is learned – something which everybody engaged in science education should read for the breadth and depth of what it has to say. Reading it was an illuminating experience seeing how the threads of various pieces of research had been carefully crafted into a coherent thesis. What is also interesting is that the range of sources drawn on is so extensive that this report will offer even the most knowledgeable in the field something to extend or challenge their perspective.

The review takes a very positive view of what children can achieve notably rejecting, either explicitly or implicitly, Piagetian developmental perspectives as being outmoded and no longer justified. In this it should be applauded. What it seeks to argue is that there is good evidence that young children can achieve levels of abstract thinking that Piagetians would have implied were unattainable. In doing so, however, the report is in danger of throwing the baby out with the bathwater as there is a sense that it has, perhaps, been blinded by the evidence it has chosen to present. It recognises, for instance, like one of its much cited authors (Metz, 1995) that children are different in their cognitive capabilities but denies that it is in their capability for abstract thought. The difference cannot simply be then that the adult knows more than the child – a view that was pervasive at the beginning of the last century – as the only obstacle to children's learning would be the acquisition of such knowledge. It is unfortunate that such an old-fashioned view of Piaget's ideas are presented here. A contemporary perspective would argue that such ideas have much to offer in explaining why certain ideas in science are difficult and that the function of school science is to accelerate a child's cognitive development not to place limits on it (Shayer & Adey, 2003). The denial of the value of this perspective becomes more problematic for the report when it later argues that there is a failure to construct curricula in 'developmentally informed ways' (Ch 8, p4). The answer provided by the report is the notion of detailed maps of how children's ontological and epistemological understanding develops in specific domains – what are termed learning progressions.

The report is also heavily influenced by contemporary philosophical perspectives on what it is that constitutes science and what, therefore, it would mean to learn science. In essence, it sees science as a rational process in which reasoning and argument are the means by which scientific knowledge claims are tested. In a similar fashion it argues, therefore, that such a process should be at the heart of learning science. That, in short, that a major element of science education for young children should consist of opportunities to engage in extended enquiry, collecting data, transforming that into evidence and critically examining any claims for its implication. As somebody who has argued in many ways e.g. (Millar & Osborne, 1998; Osborne, Ratcliffe, Collins, Millar, & Duschl, 2003) that science education should develop an understanding of how scientific knowledge is constructed it is difficult to disagree with this position. It is also gratifying to see that the report recognises the value of teacher directed instruction as well as opportunities for sustained exploration. Nevertheless, there is an implicit assumption here that the doing of science and the learning of science are one and the same thing. This is a dangerous elision as the two are distinct having as they do, different goals, different institutional structures and different mechanisms for accountability.

Where the report is very realistic is in documenting what we know about the gulf between current practice – what teachers commonly do now, and what societies might hope to achieve. The discussion of how teachers might be supported to develop the vision of best practice that is offered demonstrates what an enormous mountain, not just in the US but in most countries there is to climb. As it eloquently argues, teaching science is job that requires good subject knowledge, good pedagogical knowledge and an understanding of the practice of science itself. Never having been practising scientists, many teachers suffer from limited understandings of what scientists do. Not surprisingly it is difficult to represent that which they have never seen. The report is also good in making the case for assessments which match the goals of the curriculum – both of a formative and summative nature. The case for formative assessment and its value for learning is well-known (Black & Wiliam, 1998). The case for the significance of summative assessment is less well-developed and it is good to see a cogent case made here that, in an environment of accountability and high stakes testing, devoting significant energy to the improvement of such work should be a priority.

The major recommendation of the book is a call for the evidence of research to inform practice – in particular for the development of learning progressions which show how the construction of a scientific understanding, informed by research, is more likely to help students understand and use scientific explanations; generate and evaluate scientific evidence; and understand how personal and scientific knowledge are constructed. In short, to develop both students' understanding of the ontology and epistemology of science in ways which are informed by research. To exemplify what it means, the last chapter draws on the fairly extensive body of literature in the field of students' understanding of atomic and molecular theory to show how such learning progressions might take us from the concepts and reasoning of students entering school to those ideas which society sets as the goal for children of age 14 to understand.

Fundamentally, the report here is a call for research to inform the construction of curricula, and where the research is missing or rather thin, for more to be undertaken. All of us who work in research science education will support such an argument. After all, what is our work about if our ultimate goal is not to improve the experience and effectiveness of teaching and learning science in classrooms. My caveats here are twofold. First, the example given – atomic and molecular theory – is undoubtedly important. However, the manner in which it is presented is still redolent of the foundationalist approach to canonical science. My concern about such an approach is that if you fail to understand a key element the whole edifice, then its relevance and meaning collapses. Therefore, if we are to construct learning progressions, it is essential not only that we articulate the end point but that we start with the end point – a technique which is commonly used by those who are familiar with any of the better products of popular science. Only by laying out the grand stories that science has to tell can we hope to captivate the imagination and interest of young children to stay with us on this journey. So why do you look like your parents? Because there must be something in every little bit of you which tells your next incarnation how to make a copy. What happened to the dinosaurs? Why did they die out and how did we come to be? And my favourite – hold up your hand you are looking at stardust made flesh – over 95 percent of the matter was synthesised in a star millions of years ago. How do we know? Why we should believe these and other stories raise the epistemic aspects that this report rightly considers so important.

My second caveat is that it is one thing to set out the goals and the path by which a student must progress to get there. However, it is another thing to travel that road. Teaching and learning is a product of three aspects – curriculum (about which this report has a lot to say), pedagogy and assessment – about which it has less to say – although in its defence, this was not part of its brief having been addressed by a previous report (Wilson & Bertenthal, 2005). However, all of us working in this field need to be wary of emphasising the first at the expense of the other two, which are as central, if not more, to transforming practice.

Finally, some might find the book irritatingly parochial – a criticism that can be levelled in more than one way. The first is self-evident. This is an American report intended for an American audience. Hence, it is steeped in the language of the American educational system that the uninitiated will simply have to work their way around. More seriously is the fact that the literature on which it draws is overwhelmingly from the US. Even their Canadian colleagues do not get much of mention. The question this invites is whether the quality of American Educational research is so much better than that undertaken elsewhere? In one sense, the answer is yes. Anybody who knows anything about the American context cannot help be overwhelmed by the scale and quality of the academic enterprise. In part, despite their many protestations, this is because the extent of the funding available makes that provided by the EU or in the UK seem paltry. Nevertheless, there is good work that has taken place elsewhere and more recognition for it would have helped the wider credibility of the report.

These criticisms do not undermine, however, the impression that what this volume provides is a substantial contribution to the field. What it offers is a scholarly and rigorous summary of the current understanding of the capabilities that children can demonstrate; the goals of science education; and the ways in which those might be achieved. In short, it should be compulsory reading for all who have any interest in science education.

REFERENCES

Abell, S., & Lederman, N. G. (Eds.). (2007). *Handbook of Research in Science Education*. Mahwah, New Jersey: Lawrence Erlbaum.

Black, P., & Wiliam, D. (1998). *Inside the Black Box: Raising standards through classroom assessment*. London: King's College.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How People Learn: Brain, Mind & Experience in School*. Washington: National Academy of Sciences.

DeBoer, G. E. (1991). *A history of ideas in science education : implications for practice*. New York: Teachers College Press.

Donovan, S., & Bransford, J. D. (2005). *How Students Learn Science in the Classroom*. Washington, D.C.: The National Acadamies Press.

Metz, K. E. (1995). Reassessment of developmental constraints on children's science instruction. *Review of Educational Research, 65*, 93-127.

Millar, R., & Osborne, J. F. (Eds.). (1998). *Beyond 2000: Science Education for the Future*. London: King's College London.

Osborne, J. F., Ratcliffe, M., Collins, S., Millar, R., & Duschl, R. (2003). What 'ideas-about-science' should be taught in school science? A Delphi Study of the 'Expert' Community. *Journal of Research in Science Teaching, 40*(7), 692-720.

Shayer, M., & Adey, P. (Eds.). (2003). *Learning intelligence : cognitive acceleration across the curriculum from 5 to 15 years*. Buckingham: Open University Press.

Wilson, M., & Bertenthal, M. (2005). *Systems for State Assessment*. Washington, DC: National Research Council.

Jonathan Osborne, Ph.D.
King's College London
Strand, London
WC2R 2LS, UK
E-mail: jonathan.osborne@kcl.ac.uk

Professor Osborne holds the Chair of Science Education at King's College London where he has been since 1985. His research is devoted to improving the quality of science education and learning. In particular he has undertaken work on students' attitudes to science; strategies and approaches to encourage the consideration of evidence and argument; young children's understanding of science and informal learning. His research interests in the latter context lie in promoting and initiating discourse about science in informal arenas and in exploring narrative as a mode of communicating ideas in science.