

Book Review

Progressing Science Education: Constructing the Scientific Research Programme into the Contingent Nature of Learning Science

Keith S. Taber

London: Springer (2009) pp. 402 Hbk. £136.00

ISBN 9789048124305

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For many science educators currently working in industrialised cultures constructivism, particularly social constructivism is the undisputed methodology on which their own learning, and subsequent teaching, has been premised. It has become so embedded in science education practice that few question its dominance as a paradigm for instruction or research. However, critics argue that its weak methodologies and relativist epistemologies render constructivism an 'empty mantra' (p2) which undermines, rather than supports science education practices.

In *Progressing Science Education*, Keith Taber provides a comprehensive defence of constructivism. He argues that how scientists work within constructivist research into science education may be different from natural science enquiry, but it is nonetheless equally robust. By contextualizing his defence within Lakatos' Scientific Research Programme (SRP) theory he links an intensely academic argument to the classroom context.

Taber opens with a review of educational enquiry as it relates to the learning sciences, which encompasses cognitive theory, educational theory, and neuroscience, highlighting the shift from Piagetian learning stages in cognitive development to an interest in learners' ideas in conceptual development. He situates educational research within the present cultural context of Western scientific thought and within psychology. He reviews perspectives on knowledge/learning, before concluding that no single viewpoint can capture the essence of learning. Next, Taber establishes the criteria for evaluating science as a system of enquiry. In presenting key ontological and epistemological positions that frame the current debate; namely positivism, relativism, and the nomothetic/ideographic divide he concludes that they are separated by degree rather than incompatibility.

Eschewing the objectivist/subjectivist debate, Taber introduces Lakatos' criteria for deciding what scientific SRP based on a 'hard core' of axioms held unchangingly over time. While these assumptions are not usurped by contradictory evidence and better theory, then the research programme can be viewed as valid. If these core axioms are supplanted the SRP will be superseded by a new research programme (RP). However, if lively debate of competing theories and evidence results in refinement of these axioms then the SRP is moving forward or 'progressive'. Effectively, Lakatos' SRP changes the terms of engagement, as the 'hard core' does not hold an epistemological based view on the status of scientific knowledge, criticisms of relativism cannot be used to unseat constructivist tenets.

In applying Lakatos' SRP to constructivism, Taber draws on the work of Driver and Erickson, Gilbert and Watts and others to derive the following assumptions:

- Learning science is an active process of constructing personal knowledge.
- Learners come to science learning with existing ideas about many natural phenomena.
- The learner's existing ideas have consequences for the learning of science.
- It is possible to teach science more effectively if account is taken of the learners' existing ideas.
- Knowledge is represented in the brain as a conceptual structure.
- Learners' conceptual structures exhibit both commonalities and idiosyncratic features.

- It is possible to meaningfully model learners' conceptual structures. (p123)

Against these clearly defined criteria for constructivism, Taber demolishes the criticisms from within and outwith the field.

With the 'hard core' axioms successfully defended, attention turns to the progressive nature of the research programme to demonstrate that the evidence and theories are far from stagnant. Although Taber describes his account as 'subjective' his review of constructivist research in science is both comprehensive and inclusive: although there appears to be less emphasis on biology than physics or chemistry. Evaluating against the criteria, he concludes that the current research programme is sufficiently progressive for its age and state of maturity.

The final chapter sets out future research priorities which include studying individual learners in depth, following changes in conceptual understanding over extended periods of time, learning within specific teaching contexts and learning in groups. Taber also advocates a mixture of in-depth, longitudinal and naturalistic studies together with quantitative surveys and interventions. In conclusion, he points out that the aim of educational research is to inform pedagogy and enhance learning; therefore findings must ultimately be related to learning outcomes in the classroom.

This densely written, highly structured, copiously referenced and exhaustively indexed this book requires application and dedication from the reader for full appreciation. However, as a resource for researchers this volume will challenge and support their work for years to come.