Book Review

Black, Paul & Atkin, J. Myron (Eds.). (1996). *Changing the subject: Innovations in science, mathematics and technology education*. Routledge, $18.95 (paperback), 230 pp. (ISBN 0-415-14623-2)

Reviewed by Ann Marie Hill and Gary Hepburn

Changing the Subject: Innovations in Science, Mathematics and Technology Education, edited by Paul P. Black and J. Myron Atkin, is one of the latest in the genre of Mathematics, Science and Technology (MST) publications. The book was sponsored by the Organization for Economic Co-operation and Development's (OECD) Center for Educational Research and Innovation (CERI). The content of the book draws on 23 case studies from 13 different countries. Most of the studies concentrate on one of the three subject areas: nine focus on science education; seven on mathematics education, and two on technology education. One of the mathematics education studies deals with the use of computers for instruction. The remainder of the studies involve integrating subject areas, with four studies focusing on science and mathematics education and the remaining study on science, mathematics, and technology education. The age range of the students in the various case studies is from 4 to 19 years. Some of the case studies had a very narrow age range (e.g., 13 to 14 years) while others were more diverse (e.g., for example, 5 to 18 years). These and other details for each case study are documented in an Appendix titled, *Summaries of the 23 case studies*. Readers need to familiarize themselves with the summaries to contextualize the reporting throughout the book.

The first part of the book title, *Changing the Subject*, has several possible interpretations. The subject to be changed could be education in general or it could be the subject areas of science, mathematics, and technology, either as individual subjects or as MST, an integrated subject. The book title could also consider students or teachers as the subjects that are to be changed. Although reading the book does little to indicate which interpretations the editors of the volume have in mind, there may be some value in the ambiguity of the title as each of the possible interpretations represents an important facet of a complex task. The second part of the title, *Innovations in Science, Mathematics and Technology Education*, is indeed indicative of the various foci of the text. While the book does deal with each of the three designated subjects, it is predominantly about *science*. Mathematics receives somewhat less attention than science, and technology ends up with an even lesser profile.

Reporting in Science, Mathematics and Technology Education

Chapter 2 is primarily concerned with changing conceptions of science and mathematics, with an emphasis on science. Little reference is made to

technology education. When mentioned, technology is frequently depicted as computers. An example of such a reference is, "Students use contemporary technology and, especially, learn its power to gather and manipulate data more efficiently" (p. 38). The summary below provides a sense of the dialogue throughout the book with respect to the three subjects.

Science

The reporting on science education depicts a movement from a transmissive model towards a constructivist view of learning by attending to students' prior conceptions and recognizing that students are active constructors of their own knowledge. Here science is used to achieve general learning outcomes involving the development of intellectual and social skills. The authors see these changes moving science education from a "purist" view of science towards one that appreciates "science in action" which consists of "real and messy everyday problems." The authors state that, "Students' scientific work also involves practical activity, collaboration in thoughtful investigation which has to confront hard evidence, and the problems of their personal and social lives" (p. 88).

Mathematics

Descriptions of changes in mathematics education are presented as being much like changes in science in the sense that new collaborative, team approaches are being used. Reported on as well is a move from "pure" to "applied" where a greater relation of real problems from the world outside the school has increased student motivation. The authors document the use of educational technology, e.g. calculators, as important in the transformation of mathematics education.

Technology Education

While technology has perhaps the longest history of the three subjects that are the focus of the book, it is largely depicted as a subject without a history. It is seen only as a newcomer relative to science and mathematics. Technology is not examined in its own historical context or in the same detail as science and mathematics. In the absence of a more developed history and description, it is difficult to assess the validity of some of the claims that the authors make concerning technology education. For example, the authors claim that although technology education has always been founded in practical activities, these activities have not always been based on real world contexts. In addition they claim that there is a movement towards greater "theoretical reflection about the nature and influences of technological activity." While these are important issues for technology educators to consider, a more insightful view of technology education would have provided these claims with merit. Such a view would have been particularly helpful for understanding the context of an additional claim that is made concerning the high degree of resistance from students and teachers to many of the changes being advocated.

Discussions of integration in the volume tend to underplay the role and contribution of technology education in relation to the other subject areas. This

is evidenced in the following statement which seems to place technology in a marginal location relative to that assumed for science and mathematics:

> The new connections among the disciplines can be seen in the case studies in several manifestations. In some the aim is to relate the science disciplines to one another in what is called 'integration.' Others seek to connect science with mathematics. Still others relate science and/or mathematics with other disciplines such as social science or technology. (p.41)

The limited exploration of the relation of technology education to other areas fails to address such questions as: Is technology education like the other subjects? What does it offer them? What can it learn from them? What does it offer the other subjects? Without this sort of exploration, it is easy for technology to be integrated with other subjects primarily as a resource, as frequently described in the book.

Methodological Issues

The approach taken in this volume to reporting on the case studies raises at least two methodological issues. The first of these is a dilemma which has been played out in other similar projects. By creating a "final distillation" (p. 2) of the 23 case studies, the value of the research in the individual case studies may be compromised. Case studies are studies of the particular (Yin, 1994), and the valuing of the particular was the overall focus of this project.

> [The book] is authentic. In drawing on case studies, we have let the actors in their narratives speak in their own voices, out of their own preoccupations.
> . . . [E]verything that this book has to say rests on the concrete foundation of what somebody has actually done or said, in a specific and well described context of place and practice. (p. 3)

Moving from the case studies, which gain their strength in being grounded in the particular, to a general story removed from any particular context is a complex and problematic methodological move. Can a book which strips the context from the evidence it draws upon make a claim to authenticity on the basis that the context had been accounted for in an earlier form of the work? The dilemma is one that must be played out in order to put the results of 23 case studies in a form that educators and policy makers are likely to read. To its credit, this book did much to keep the individual case studies in view by referring to them and encouraging readers to consult them directly. The book, however, would have gained considerable strength through a reflexive examination of some of the methodological issues addressed in similar projects (e.g., Gaskell, 1996; Stake & Easley, 1978).

The second methodological issue was the decision to postpone making references to literature relating to the science, mathematics and technology education as well as to the theoretical frameworks that were employed until future analysis is carried out. Stated simply, the book is compromised without a

bibliography! While this did have the effect of enabling the editors to focus on the important points that emerged from the cases themselves, it also obscured other important points. An instance is seen in Chapter 3, dealing with teaching and learning.

Although constructivism is the only learning theory that is explicitly mentioned, other theories of teaching and learning environments are implied at several points. These include theories of situated cognition and theories of learning styles. A more direct consideration of learning theories would have done much to highlight some important differences underlying the three subjects. For example, while constructivism has been very influential in science education in recent years, technology education has historically relied heavily on theories of experiential learning. By not dealing explicitly with the literature and theory related to the subject matter of the book, the authors were unable to interrogate some of the issues that appear to be germane to the analysis they carried out.

Final Overview

The 23 case studies no doubt provide important contributions to knowledge in the individual subject areas that each addresses. However, *changing the subject* really seems to be about changing *science* education. Technology education is particularly short-changed and an inadequate understanding of this subject is evident.

Fundamental differences between subjects were *not* accounted for in the book, such as the historical differences in the clientele of the various subjects, the different problem solving approaches used in each subject, different ways the practitioners of the three subjects see the world, and how each addresses different human abilities. Despite this overall character to the writing, there is the occasional hint that the authors recognize subject differences, for example, when discussing assessment, they state, “Assessment must be capable of responding differently to the different epistemological constraints that govern the organization of knowledge in each discipline” (p. 98).

Given its descriptive approach, the book falls short of providing an analysis and framework as promised. An analysis of the distinctions between science, technology and mathematics, how and where these subjects intersect and become interdisciplinary or integrated, and the advantages and limitations of integration is research that could lead to a better understanding of the three subjects. A theoretical framework for this understanding has yet to be developed.

Many of the innovations presented in the book are a response to the changing clientele teachers encounter in these subjects rather than to a transformed view of the subjects. New practical demands and a search for relevance are perhaps the greatest drivers of innovation, and may well be the thread that will tie the three subjects together into a fully realized MST subject area.

Despite some of the volume’s shortcomings, it is worthwhile reading for those interested in innovation in science, mathematics, or technology education.

Perceptive insights gleaned from the case studies are discussed in a way that allows readers to begin to appreciate the complicated nature of such undertakings.

References

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Yin, R. K. (1994). *Case study research: Design and methods*. (2nd ed.). Thousand Oaks, CA: Sage.