VISUALIZATION: THEORY AND PRACTICE
IN SCIENCE EDUCATION

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Introduction

John K. Gilbert, Miriam Reiner and Mary Nakhleh

Interest in the educational value of material objects, pictures, diagrams, tables, graphs and the like, in science education has increased greatly in recent years (Gilbert, 2005). This has been facilitated to a large extent by the exponential rise in the memory capacity of personal computers and to the associated investment made in software development, which have combined to enable major innovations in instructional techniques to take place. For any educational innovation to succeed – to be widely adopted and persistently practiced – three associated aspects of any pedagogic innovation have to be initially addressed. Practical, user-friendly, examples of the innovation must be developed, tried out in classrooms, and their use evaluated. The contribution of the innovation to the curriculum must be explored – an identification of where the innovation may be used either to improve existing educational practice or to provide new forms of instruction. Why an innovation is successful – why it makes a worthwhile contribution to learning – must be established. These three aspects are inter-related and should be mutually reinforcing. The biggest issue of all – the provision of widespread and effective opportunities for teacher 'continuing professional development' in respect of the innovation – must be addressed from the outset.

The problem in many such cases, and certainly the case here, is that each one of these aspects is taken as a focus for work by a different academic community. The development of practical examples of such innovations is undertaken by the science community, often primarily interested in their use within scientific research and perhaps secondarily in their use in the training of future scientists. The curricular contribution of these innovations and opportunities for continuing professional development receives the attention of the science education community. The nature of their contribution to learning is seen as the province of the cognitive science community. The success of this type of innovation is hindered because these communities are not in any systematic direct contact with each other. We believe that one of the strengths of this book is that it brings together a collection of papers that contain the theoretical perspectives, understandings, and frameworks of several of

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these communities. We hope that this book can serve as the beginnings of a bridge between these diverse communities.

However, a lack of communication means that the drawing together of the contributions to the field by authors from diverse academic backgrounds will be hindered by their use of different specialist terminologies. Key words may be used in different ways, yet a commonality of meaning must be established if insights are to synthesised and new perspectives opened up. There are two generic systems in use in this area of innovation. In Convention 1, a representation is the depiction of anything; an external representation is one that has been placed in the public realm, in either a material object, visual, verbal, or symbolic form; an internal representation is one that is constructed mentally by an individual; a visualization is the understanding of, the meaning attributed to, an internal representation. In Convention 2, a visualisation is a representation that has been placed in the public realm in either material object, visual, verbal, or symbolic form; the mental representation produced by an individual from a visualization is an image. The difference between the two Conventions lies in the meaning of the word visualization: in Convention 1 it is a verb (to visualize something is to mentally act on it); in Convention 2 it is a noun (a visualization is something that is in the public realm). There are, inevitably, phrases that cut across the two conventions: 'visual representation', 'visuo-spatial thinking', 'representational insights'.

We have brought together the chapters of this book to promote the formation of links between those concerned respectively with theory, curriculum place, and pedagogic practice. In writing for and editing for it, we have decided to adopt Convention 1, for we wish to place the emphasis on the nature of the mental actions undertaken by individuals in using representations. Some of the contributing authors have adopted Convention 2. In order to avoid confusing the reader, where the word visualization is used in the Convention 2 sense, we have entered it as 'visualization', leaving the use of the word without parenthesis to be the meaning in Convention 1.

The book is divided into three Sections, dealing respectively with the first three aspects of innovation in respect of external representation, internal representation, and visualization.

Reference

Gilbert, J. K. (Ed.). (2005). *Visualization in science education*. Dordrecht: Springer.