



Why another book about primary school mathematics?

Over the last two decades there has been a fight for control of education. On the one side there is the professional knowledge of teachers and educators, and new insights into learning from neuroscience and psychology. These give strong messages about how individuals learn and how people collaborate successfully in groups and teams. On the other side there has been a political desire to reduce teaching and learning to the level of technical problems, and to oversee and control public education. This political approach has often sought to recast learning and teaching as a series of simple steps, easily delivered through learning packages with predictable outcomes. Such an approach has encouraged too much of a focus on individual performance, competition and the measurement of attainment.

International comparisons of children's standards show the UK slipping down the league tables. In many cases the UK appears to be falling behind countries like Finland and Japan. Many of the more successful countries and jurisdictions have school systems that are less centrally regulated. This suggests that central control does not raise standards beyond a basic level. As a country we need to go further, to raise standards beyond the adequate, to ensure that students enjoy learning maths, and to create the kind of enthusiasm that leads to students choosing mathematics-related careers. To do this requires a letting go of control and an increase in freedom, diversity, creativity and innovation in classrooms and schools.

Our chosen route has been to draw upon evidence from research and professional practice. This book is a form of encouragement to teachers, learning support staff and parents to teach mathematics in an experimental way, in the hope that they will follow their own curiosity and enthusiasm and help sustain the same excitement in the children with whom they work. The book acknowledges the constraints faced by teachers and children in formal educational settings and offers strategies for coping with the challenges faced by professional teachers and home educators.

The Really Useful Maths Book:

- provides a broad curriculum framework for mathematics;
- introduces ideas that are open to exploration and interpretation;
- offers a variety of ways to think about and explore mathematics;
- tries to stay with complexity rather than seek simplistic solutions;
- provides a basis for thoughtful pedagogical planning and documentation.

Mathematics remains a difficult subject to learn and to teach. This is due in part to the complexity surrounding the ways in which humans learn new ideas. We are gaining deeper understanding of these processes from neuroscientists and psychologists such as Daniel Kahneman (2011). Mathematics also remains difficult because of the elaborate interactions between learners' emergent mathematical thinking and the objects used to

represent mathematics: sticks, pebbles, counters, marks in sand and mud, signs, images on paper, measuring instruments, symbols and abstract mathematical rules.

The Really Useful Maths Book contains a rich and wide ranging collection of mathematical activities suited to most children in the early years and primary school age range. In this second edition, we have been encouraged to include more activities for younger children.

In Part I we provide maths activities that require less pedagogically complex classroom settings. These activities are suitable for everyone who teaches children. In particular they are likely to suit:

- beginner teachers;
- adults with limited experience of teaching mathematics;
- parents who want to support their children's mathematical learning.

Part II presents a more challenging approach to teaching mathematics. We recognise that many teachers work in complex environments, for example with large classes, split year groups and other challenges that require more complex pedagogical strategies. Our purpose in Part II is to develop:

- deeper insights into more complex mathematical relationships;
- greater depth of thinking about the pedagogical challenges of teaching and learning maths;
- more challenging explorations based on Part I activities;
- practical activities and projects that extend beyond a single lesson.

Part III contains an eclectic mix of additional resources including the usual bibliographies and references. Many of the resources listed are web based and include; videos demonstrating exciting approaches to maths, video games and a wide range of alternative suggestions, ideas and sources that go well beyond what we can provide within the pages of a single book. These will be echoed on the companion website, which can be found at www.routledge.com/cw/Brown.

INTERACTIVE TEACHING

Successful learning and teaching are enriched by human interaction, good relationships and mutual respect. *The Really Useful Maths Book* draws on research from the science of education to explore how to get the most out of *interactive ways of working*. For us *interactive teaching and learning* suggest dynamic relationships between adults, children, classroom equipment and other mathematics resources. We believe that this dynamic interaction in the classroom, which some Early Years researchers refer to as *intra-active pedagogy* (Lenz Taguchi, 2010), encourages a democratically aligned education process, which emphasises classroom interactions (intended and unintended), between:

- each and every child and its peers, and between the child and the teachers;
- the teachers and the mathematics, including maths symbolism, maths equipment and resources;
- students and the mathematics including the mathematical objects (both real and abstract) explored in classroom activity.

This highly complex state of learning and teaching, which experienced teachers will recognise intuitively from their classroom experience, can be represented by a deceptively simple triangle model:

A model for interactive teaching

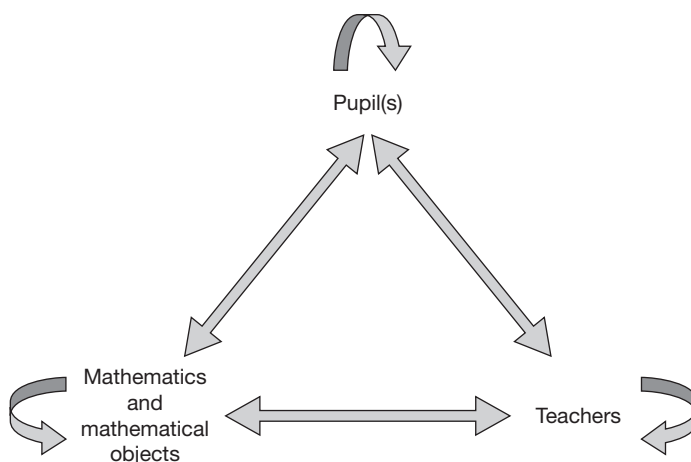


Figure 1 Triangle of interactions

This interactive teaching model has several key elements, illustrated by the diagram above. Principally, each vertex of the triangle of interaction, representing in turn, *pupils*, *teachers* and *mathematics* (including mathematical objects and classroom resources) is involved in complex interactions with the other two vertices. These interrelationships are the substance of interactive teaching, which we explore in detail in the different sections in Part II.

STARTING POINTS FOR MATHS ACTIVITY

Maths activities in three dimensions

In our own planning and teaching, we have used three dimensions – or ways of presenting mathematics to children – that help create a maths curriculum which is rich and diverse, broad and balanced. This approach helps to connect the outer world of mathematics to the children’s inner imaginative world by drawing on:

- 1 *Fantasy worlds* as well as the *living world*, to include stories, poetry, myths and legends as well as factual information about the world in which children live.
- 2 *Practical activities and problems* that need to be solved, using situations that children experience as ‘real and relevant’, while avoiding repetitive computational practice that is unrelated to either children’s interests or mathematical need.
- 3 *Global issues* as well as *local* or *classroom-based* challenges. This can be considered within an EfS/GL framework (Education for Sustainability and Global Learning) or a personal to global dimension.

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Maths in a democratic society

The Really Useful Maths Book promotes a democratic approach to education. We believe that a democratic society that takes responsibility for the education of all its children should also take some explicit positions on the *beliefs, values, aims* and *processes* that emanate from the state provision of education, and that these positions should be the driving force for seeking progress in learning and teaching.

Towards an economy of learning

We draw on Caleb Gattegno's science of education to argue that teachers should search for economies of learning for their students. This involves making students aware of internal relationships, structures and patterns in mathematics in ways that reduce the burden on memory. Knowing the equivalence relationships between addition facts like $2 + 7$ and $7 + 2$ and multiplication facts such as 4×7 and 7×4 reduces the number of facts to be learned.

We draw on the work of Reuven Feuerstein to argue that successful learning occurs when students make *links* or *bridges* between different areas of knowledge, different mathematical concepts, and between new and previously acquired insights. We draw on various authors when we discuss students' misconceptions and errors in mathematics. We argue that the most successful learning occurs when students have opportunities to exercise choice. Motivation and success are likely to be greater where students can exercise some independence when choosing their own approach to tackling maths problems or to working on classroom activities.

Readers who are most likely to find *The Really Useful Maths Book* of benefit are those who have gained sufficient freedom to experiment with their own teaching, their own learning of mathematics, and their professional interactions with students and others.