

Contents

Preface	v
How to Use This Book	v
About the Author	vi
1. The Mathematical Brain and High-Impact Teaching	1
Teaching Mathematics Through Differentiating Instruction	1
The Mathematical Brain	3
Brains as Prioritising Filters	7
Number Sense	8
Multiple Intelligences: Avenues for Learning Maths	9
Summary of Brain Research	11
Instructional Phases for Developing Maths Skills	15
Teaching Strategy: Mathematical Games to Develop Number Sense	18
SHEMR: A Tool for High-Impact Learning in Mathematics	20
Evaluating One's Own Instructional Planning	24
What's Next?	27
2. Differentiated Instruction and Response to Intervention in Mathematics	29
Differentiation and Response to Intervention: Refocusing Maths Instruction	29
Teaching Phases in the Direct Instruction Lesson	31
Problems With Direct Instruction in a Large Class	32
Teaching Strategy: The Guess, Assess and Tear Out Tactic	33
A Differentiated Instruction Lesson Example	34
Teaching Strategy: Using Guess, Assess and Tear Out! Moving From Direct Instruction to Differentiated Instruction in Maths	34
The Omega Group	36
The Mainline Instruction Group	38
The Beta Group	39
Is Further Differentiation Needed?	40
Anything Wrong With This Scenario? Enhancing the Differentiated Instruction Model	41
Guidelines for Differentiated Lesson Planning	42
Results of Differentiated Lessons	45
A Differentiated Instruction Overview: What It Is and What It Isn't	46
Response to Intervention in Mathematics	47
Case Study: An RTI for Number Sense and Early Maths Skill	48
What's Next?	55

3. Differentiating for Primary Maths	57
Research on Maths Readiness	57
Steps in Developing Early Maths Skills	58
Teaching Strategy: A Concrete, Semi-Concrete, Abstract Learning Tactic	61
Using CSA in the Classroom	65
CSA in the Higher Year-Levels	67
Summary: The CSA Tactic	70
Teaching Strategy: The Errorless Learning Procedures	71
Summary: Errorless Learning	75
Teaching Strategy: Classwide Peer Tutoring for Differentiating in the Maths Class	75
What's Next?	77
4. Differentiating for Deep Conceptual Understanding	79
High-Impact Teaching for Operations in Maths	79
The Debate on Calculators in Primary School Mathematics	81
Constructivist Theory and Understanding of Mathematics	82
Using Cognitive Guided Visualisation	85
Scaffolded Instruction in Maths	86
Debate on What a Scaffold Is	88
Graphic Representations of Word Problem Schemas	91
Using a Representational Strategy	93
Teaching Expanded Notation and Partialling	94
Process Mnemonics Strategies to Teach Computation	96
What's Next?	99
5. Differentiating With Learning Strategies	101
The Brain Research Basis for Metacognitive Theory and Tactics	101
Learning Strategies for Word Problems	104
The Schema-Based Maths Strategy	109
Differentiated Tear Out Activities for Story Problem Schemas	114
What's Next?	115
6. Differentiating in the Middle Years	117
Working Toward Higher-Order Thinking	117
Teaching Strategy: Anchored Instruction	118
Teaching Games in Higher Year-Levels	122
The PASS Strategy	123
Moving on Up! Maths Instruction Guidelines for Secondary Learners	128
References	130

Preface

HOW TO USE THIS BOOK

This book is intended for teachers who want additional ideas for differentiating instruction in the primary school maths class. It is not intended as a text, but rather as a practical applications book.

I understand that teachers are very busy, and I wanted to develop a helpful book, filled with practical suggestions that can be immediately useful. Many of the simple tactics and instructional ideas here are forthright and may be immediately applied in almost any classroom. The instructional sections

The good news is that you don't need to read the book from cover to cover!

labelled "Teaching Tactics" and "Ideas From Teachers" represent immediately applicable ideas that should assist maths teachers from prep to Year 8. In particular, the "Ideas From Teachers" sections offer real-world differentiated instructional applications that teachers have suggested over recent years. If your time is limited, feel free to skip through the book in no particular order, looking at the sections that offer these helpful, easy to implement, practical tactics. Once you apply them, you'll find that your students' understanding and enjoyment of maths skyrocket!

The "Teaching Tactics" describe instructional ideas in maths that involve more complex instructional procedures than merely a new way to use music or movement to teach a simple maths concept. These strategies represent the most effective way to differentiate within the maths class, and thereby meet the needs of all the students. These strategies are theory based, and enough information is provided for you to implement these strategies in your own class.

I have also provided "Website Reviews" in most chapters. Of course, these are not thorough critiques of these websites, nor does this brief list by any means exhaust the websites available to assist in mathematics instruction. Still, the use of these websites can greatly enhance your instructional efforts in maths. Also, the links provided here will help you in your move towards a more differentiated maths class.

Chapters 1 and 2 present the basics of differentiated instruction as applied in the maths classes. Here, the recent response to intervention (RTI) initiative is discussed briefly as it will impact the types of instructional opportunities provided in mathematics for many students in the primary years. In Chapters 1 and 2, you can learn what a differentiated maths class looks like and how to establish a differentiated maths lesson plan. The remaining chapters present instructional practices for a wide variety of specific areas in mathematics. Each of the chapters features the specific sections noted above, and each should provide you with some novel teaching ideas for differentiation in your classroom.

I sincerely hope this book assists you in your efforts to move toward differentiation in maths, and I would be more than pleased to hear your thoughts on this book and/or your suggestions for additional instructional tactics that would help other teachers differentiate lessons in their maths classes. Please feel free to contact me directly (766 Collins Rd., Toccoa, GA 30577, USA) with your thoughts or teaching suggestions. I do appreciate your thoughts, suggestions and teaching tactics, and I look forward to hearing from you!

1

The Mathematical Brain and High-Impact Teaching

Strategies in this chapter include the following:

- Ten Brain-Compatible Teaching Guidelines for Maths Instruction
- Ten Informal Tactics to Develop Number Sense
- Games and Activities for Developing Number Sense
- Ten Teaching Tactics for High-Impact Learning in Maths
- A Self-Evaluation Grid for Differentiated Instruction Lesson Planning

TEACHING MATHEMATICS THROUGH DIFFERENTIATING INSTRUCTION

Over the past two decades, we have witnessed an emerging emphasis on mathematics instruction, and as a result achievement in maths among students has been increasing (Clarkson, Fawcett, Shannon-Smith, & Goldman, 2007; Fuchs et al., 2008; Fuchs, Fuchs, Compton, et al., 2007; Harniss, Carmine, Silbert, & Dixon, 2002). In fact, within the past several years, maths scores have increased (Strauss, 2003). However, there is still a significant concern relative to mathematics performance. Recent research has documented the fact that approximately 5% to 8% of school-age children are not achieving in mathematics as well as they should, given their overall ability (Mabbott & Bisanz, 2008). In fact, these students may display a mathematics learning disability, which research suggests is rooted in a variety of factors such as poor calculation strategies, lack of automaticity in maths facts, and poor working memory (Mabbott & Bisanz, 2008; Woodward, 2006).

These problems have resulted in more research attention on mathematics in recent years. The publication of revised mathematical instructional standards both in Australia and the US have placed mathematics instruction on the national agenda, second only to the emphasis on reading. In Australia, there is a push for an Australia-wide, standardised mathematics curriculum and associated standards. In 2006, the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA), the Australian Education Systems Official Committee (AESOC) and Curriculum Corporation developed and published the *Statements of*

Learning for Mathematics, in order to define common curriculum content and move towards common, shared standards. Currently much of the mathematics curriculum can vary from state to state. In the US, one of the major mathematical organisation, the National Mathematics Advisory Panel (NMAP) have recently published revised mathematical instructional standards in their report *Foundations for Success: The Final Report of the National Mathematics Advisory Panel* (NMAP, 2008).

Even prior to release of these reports, the growing emphasis on maths standards has received some degree of research and media attention (e.g. Fuchs, Fuchs, Compton, et al., 2007; Jitendra & Xin, 2002; Johnson, 2000; Jordan, Kaplan, Locuniak, & Ramineni, 2007; Miller & Hudson, 2007; NMAP, 2008; Steen, 2007). Research has shown that the vast majority of general education teachers are familiar with the standards and frequently address these standards in their teaching (Maccini & Gagnon, 2002), indicating the overall concern teachers feel concerning mathematics achievement.

Teaching tactics: Ten brain-compatible teaching guidelines for maths instruction

The emphasis of instruction in maths has changed somewhat, however. Students are expected to master a curriculum that has shifted away from computation, rote learning and routine problem-practice activities toward an increased emphasis on reasoning, conceptual understanding, real-world problems, and connections between mathematical concepts (Johnson, 2000; MCEETYA, 2006; NMAP, 2008). Thus, much has changed in mathematics instruction, and teachers today must employ the most effective and efficient instructional methods possible for increasing cognitive involvement of all students with the maths curriculum. Teachers are searching for instructional ideas that will assist in this regard.

The concept of differentiated instruction can be of great benefit to teachers in developing and designing their mathematics instruction for students with varying ability levels in the primary education classroom. Moreover, the emphasis on brain-compatible instruction, one founding principle of differentiated instruction, can now inform teachers concerning what specific instructional tactics may result in higher learning impact, as many of these techniques not only make learning more interesting, but also increase retention over the long term (Bender, 2002; Sousa, 2008; Tomlinson, 2004). While studies of how the human brain functions in reading tasks or maths tasks have been undertaken for the past several decades, only within the last fifteen years or so has this emerging biomedical research—often referred to as brain-compatible research—progressed enough to inform teachers concerning effective instructional strategies for the maths curriculum (Fuson & Wearne, 1997; Geller & Smith, 2002; Gersten, Chard, Baker, & Lee, 2002; Sousa, 2008). In particular, one aspect of this research—multiple intelligences—while dated, seems to have been somewhat revitalised, and has recently struck a chord in the hearts and minds of educators (Gardner, 1983, 1993). This perspective has provided one basis by which many maths teachers have reformulated their instructional strategies. In fact, today many mathematics textbooks present various instructional activities based on a multiple intelligences perspective. Distinct from the multiple intelligences movement, research on brain functioning at the cellular level has likewise provided some guidance for instruction in recent decades (Bender, 2002; Sousa, 2006, 2008). Both of these support the concept of differentiated instruction.