

Contents

Preface

1. **An Emerging Paradigm for Research on Addition and Subtraction Skills** 1
Thomas A. Romberg

2. **The Development of Addition and Subtraction Problem-Solving Skills** 9
Thomas P. Carpenter and James M. Moser
 - An Analysis of Verbal Problems 10
 - Empirical Findings 13
 - General Discussion 20

3. **Levels of Description in the Analysis of Addition and Subtraction Word Problems** 25
Pearla Nesher
 - Regularities Found in Solving Word Problems of Addition and Subtraction 27
 - The Logical Structure 28
 - The Semantic Component 30
 - The Syntactic Component 35
 - Final Remarks 36

4.	A Classification of Cognitive Tasks and Operations of Thought Involved in Addition and Subtraction Problems		39
	<i>G�rard Vergnaud</i>		
	Basic Categories of Relationships	43	
	Experimental Results	48	
	Are Symbolic Representations Useful?	53	
	Conclusion	57	
5.	Interpretations of Number Operations and Symbolic Representations of Addition and Subtraction		60
	<i>J. Fred Weaver</i>		
	Some Background Considerations	60	
	Some Instructional and Research Considerations	63	
6.	An Analysis of the Counting-On Solution Procedure in Addition		67
	<i>Karen C. Fuson</i>		
	Counting All and Counting On	67	
	The Structure of the First Addend In the Counting-On Procedure		68
	The Structure of the Second Addend in Counting On	73	
	Coordinating the First and Second Addends in Counting On		77
	Conclusion	78	
7.	Children's Counting in Arithmetical Problem Solving		83
	<i>Leslie P. Steffe, Patrick W. Thompson and John Richards</i>		
	Levels of Problem Solving	85	
	Summary	96	
8.	The Development of Addition and Subtraction Abilities Prior to Formal Schooling in Arithmetic		99
	<i>Prentice Starkey and Rochel Gelman</i>		
	Some Early Competencies	99	
	Piagetian Theory	109	
	An Alternative View	112	
9.	Towards a Generative Theory of "Bugs"		117
	<i>John Seely Brown and Kurt VanLehn</i>		
	The Form of Generative Theory	122	
	Repair Generation	125	
	Critics	131	
	Concluding Remarks	133	

10.	Syntax and Semantics in Learning to Subtract <i>Lauren B. Resnick</i>	136
	Distinguishing Syntax and Semantics 137	
	A Closer Look at Children's Semantic and Syntactic Knowledge 142	
	Linking Syntax and Semantics 148	
	Why Mapping Works 150	
11.	General Developmental Influences on the Acquisition of Elementary Concepts and Algorithms in Arithmetic <i>Robbie Case</i>	156
	Cross-Domain Parallels In Cognitive Development 156	
	The Role of Central Processing Capacity 160	
	Parallel Trends in the Area of Mathematics 162	
	Implications for Instruction 165	
12.	The Structure of Learned Outcomes: A Refocusing for Mathematics Learning <i>Kevin Collis</i>	171
	Background 171	
	The Response Model in Relationship to Addition and Subtraction 177	
	Conclusion 181	
13.	Type 1 Theories and Type 2 Theories in Relationship to Mathematical Learning <i>Richard R. Skemp</i>	183
	A New Model of Intelligence 183	
	A Refocusing 188	
14.	The Development of Addition in Contexts of Culture, Social Class, and Race <i>Herbert P. Ginsburg</i>	191
	Study I: Mental Addition in Cross-Cultural Context 193	
	Study II: Written Addition in Cross-Cultural Context 198	
	Study III: Social Class and Race in America 204	
	Conclusion and Implications 208	

15.	Learning to Add and Subtract: A Japanese Perspective	211
	<i>Giyoo Hatano</i>	
	Development of Number Concept and Calculation	
	Skills up to Kindergarten	211
	Acquisition of Addition-Subtraction Skills During	
	Elementary Grades	214
	Does Japanese Culture Favor the Development of	
	Calculation Skills?	217
	Concluding Remarks	221
16.	The Psychological Characteristics of the Formation	
	of Elementary Mathematical Operations in Children	
	<i>V. V. Davydov</i>	224
	The Origins of the Number Concept	225
	The Basic Concept of Quantity	228
	Curricular Implications	229
	Evaluation	235
	Conclusion	236
	Author Index	239
	Subject Index	243