

INDEX

- absolute thinking
 - connecting to additive thinking, 104–6
 - definition, 96
 - explained, 96–8
 - Titanic* example, 104–6
 - wine buying example, 97
- addition
 - of fractions, 117–19
 - repeated addition, 55, 56, 64
- addition facts, 54
- addition grids, 61–2
- additive identity, 59
- additive thinking
 - car budgeting example, 94–5
 - concrete mixing example, 92–3
 - connecting to absolute thinking, 104–6
 - definition, 88–9
 - distinguished from multiplicative thinking, 91–6
 - fruit juice concentrate example, 91–2
 - moving to multiplicative thinking, 89–90
 - recipe proportions example, 94
 - Titanic* example, 104–6
- al-Khwarizmi, 34, 35
- algebra, 34, 35
- algorithms, 34
- anxiety about mathematics, *see* mathematics anxiety
- Associative Law, 78–9
- associativity, 78–9
- assumptions, 167
- automaticity, 51–2, 65

- Base 2, 44
- Base 7, 44
- Base 10, 36, 44, 68
 - definition, 34
- Base 12, 69
- Base 60, 44
- BEDMAS, 76–7
- binary notation, 44

- calculations, using Roman number system, 36
- Calculator Crash*, 39–40
- calculators, 57, 65
- common fractions
 - addition of, 117–19
 - definition, 109
 - denominators, 110–11, 117, 118
 - difference from decimal fractions, 124
 - difficulties with, 109, 122–3
 - division of, 121
 - as divisions, 114–15
 - elements of, 110–11
 - equivalent fractions, 118, 119–20
 - improper fractions, 114
 - interpretations and uses, 111–17
 - multiplication of, 120–1
 - numerators, 110–11, 118
 - operations with, 117–19
 - part of a collection, 112–13
 - part of a whole, 111–12
 - as point on a number line, 113–14
 - power of, 116–17
 - proper fractions, 113
 - reciprocals, 121
 - representing ratios, 115–16
 - simplification, 121
 - vinculum, 110
- commutativity, 60
- co-variation
 - definition, 93
 - in nature, 99–100
 - relative thinking and, 98, 100–2
- currency exchange, 83

- decimal currency, 68
- decimal numbers, naming of, 43
- decimal place value, 42
- decimals
 - difference from common fractions, 124
 - European decimals, 42
 - understanding, 123–4
- denominators, 110–11, 117, 118
- discounting, 128–9

- dispositions
 - importance of addressing, 9–10
 - nature of, 3
 - source of negative dispositions, 6
 - towards mathematics, 6–7
- Distributive Law, 77–8
- distributivity, 77–8
- division
 - by powers of 10, 47
 - common fractions, 121
- division facts, 54–6
- equivalent fractions, 118, 119–20
- equivalent ratios, 135
- estimation, 26–7
 - checking change from cash purchases, 85
 - definition, 80
 - mental computation and, 80–2
- European decimals, 42
- factors, 55
- fractional thinking, move to, 122
- fractions
 - percentages, 126–30
 - working across three main types, 130–1
 - see also* common fractions; decimals
- fuel consumption, 144, 147–8
- growth mindset, 13–15, 161–2
- Hindu-Arabic number system, history of, 34–6, 86
- imperial measurement system, 68, 69
- improper fractions, 114
- information overload, problem of, 168
- irrelevant facts, problem of, 167–8
- knowledge of mathematics, gaps in, 4–5
- lifelong learning, 12–13
- magnitudes, judging, 27–8
- mathematical circumstances, analysis of, 3–4
- mathematical knowledge, gaps in, 4–5
- mathematics
 - difference from numeracy, 19
 - reasons for learning, 18
- mathematics anxiety
 - impact of, 8–9
 - nature of, 8
- mathematics difficulties
 - addressing, 10–15
 - growth mindset, 13–15
 - improving number sense, 10–11, 16
 - lifelong learning, 12–13
- Maths Rockx, 58
- mental computation
 - associativity and, 78–9
 - choosing strategies to aid in, 82–4
 - definition, 26, 71
 - distributivity, 77–8
 - estimation and, 80–2
 - everyday situations, 72
 - as important life skill, 73
 - improving, 74
 - order of operations, 76–7
 - overview, 71–3
 - properties of numbers and operations to assist in, 76–80
 - reasonableness of answers, 84–5
 - using number facts in, 75–6
- metacognition, 73
- metric measurement system, 68, 69
- missing information problems, 168–9
- multiple representations, 164–5, 170–1
- multiples, 55
- multiplication
 - by powers of 10, 46–8
 - common fractions, 120–1
 - complicated method, 53
- multiplication facts, 54–6
- multiplication grids, 62–3
- multiplicative identity, 59
- multiplicative thinking
 - car budgeting example, 94–5
 - concrete mixing example, 92–3
 - connecting relative thinking to, 102–4
 - definition, 29, 90
 - distinguished from additive thinking, 91–6
 - fruit juice concentrate example, 91–2
 - nature of, 90–1

- recipe proportions example, 94
 - Titanic* example, 104–6
 - multistep problems, 64–5
 - painting a wall example, 174–6
- nominal numbers, 41
- notional scales, 157–8
- number facts
 - addition facts, 54
 - approaches to learning, 57–8
 - arrays for learning, 64–5
 - auditing knowledge of, 61–3
 - learning of, 51–4
 - multiplication facts, 54–6
 - power of, 65–8
 - properties to assist learning, 59–60
 - reasons for learning, 58–9
 - using to complete mental calculations, 75–6
- number grids, 57
- number sense
 - definition, 10
 - elements of, 11
 - estimation, 26–7
 - improving, 10–11, 16, 32, 48–9, 69, 86, 107, 132, 158, 180
 - judging magnitudes, 27–8
 - key ideas of, 25–6
 - mental computation, 26
 - numerical relationships, 29
 - place value, 28
 - problem solving, 30–1
 - representational fluency, 29
- numbers, naming of, 40–1, 43
- numeracy
 - 21st century model, 19
 - definition, 19
 - difference from mathematics, 19
 - everyday examples of use, 20–2
 - importance of, 23–5
 - key elements, 20
 - role of context in, 22–3
- numerators, 110–11, 118
- numerical relationships, 29
- one, properties to assist learning number facts, 59
- one-dimensional scale, 154–5
- one-to-one correspondence, 136, 137
- operations
 - deciding which to use, 171–3
 - language of four main operators, 163
 - order of, 76–7
- parameters, 167
- percentages, 126–30
 - restaurant reviews example, 126–7
 - sale discounts example, 128–9
- personal mathematical circumstances
 - dispositional responses, 6–7
 - importance of addressing problems, 9–10
 - knowledge gaps, 4–5
 - responding to problems, 7
 - understanding the problem, 4–9
- place value
 - decimals, 42
 - as element of number sense, 28
 - as feature of Hindu-Arabic number system, 34, 36
 - grouping of digits, 40
 - naming numbers, 40–1
 - placement of digits in columns, 37–40
- Polya's problem-solving strategy, 3
 - Step 1: Understand the problem, 4–7, 16, 32, 166–70
 - Step 2: Devise a plan, 7, 10, 18, 32, 170–6
 - Step 3: Carry out the plan, 48, 69, 86, 107, 132, 158, 177, 180
 - Step 4: Look back at what you have done, 177–8, 180
- steps, 166
- problem solving
 - considering possible outcomes, 177
 - deciding what operation(s) to use, 171–3
 - definition, 160
 - as element of number sense, 30–1
 - and growth mindset, 161–2
 - irrelevant facts, 167–8
 - language of, 162–3
 - and life, 160–2
 - missing information, 168–9
 - multiple representations, 164–5, 170–1
 - multistep problems, 174–6

- not understanding all the information, 169–70
- other strategies, 176
- skills for, 162–6
- thinking mathematically, 165–6
- too much information, 168
- unfamiliar contexts, 176
- working backwards from answer, 173
- see also* Polya's problem-solving strategy
- proper fractions, 113
- rates
 - common rates in everyday life, 142–6
 - consumption, 143
 - definition, 142
 - fuel consumption, 144, 147–8
 - importance of concept, 142
 - interest rates, 146
 - long-term effects, 146–8
 - speed when driving, 144
 - unit prices for groceries, 145–6
- ratios
 - definition, 134
 - developing understanding of, 136–7
 - equivalent ratios, 135
 - fractions representing, 115–16
 - multiplicative relationships, 135
 - real-world examples, 138–42
 - representing, 134–6
 - scale factors, 153–4
- reciprocals, 121
- red herrings, 167–8
- relative size, 149–50
- relative thinking
 - branding example, 97
 - connecting to multiplicative thinking, 102–4
 - and co-variation, 98, 100–2
 - definition, 96
 - explained, 96–8
 - magpies and cyclists example, 100–1
 - misjudgment of co-variation connections, 100–2
 - Titanic* example, 104–6
 - wine buying example, 97
- repeated addition, 55, 56, 64
- representational fluency, 29
- Roman number system, 34, 35–6, 45
- rote learning, 57–8
- rounding, 80–2
- scale
 - bathroom tiles example, 155
 - definition, 148–9
 - intervals, 150
 - not to scale, 157–8
 - one-dimensional scale, 154–5
 - reading and interpreting scales, 150–3
 - relative size, 149–50
 - three-dimensional scale, 156–7
 - two-dimensional scale, 155–6
- scale factors, 153–4
- shortcuts
 - multiplying and dividing by powers of 10, 46–8
 - pitfalls of using, 45
- simplifying fractions, 121
- skip counting, 55, 58, 64
- speed when driving, 144
- subtraction facts, 54
- three-dimensional scale, 156–7
- two-dimensional scale, 155–6
- working backwards from answer, 173
- zero
 - additive identity, 59
 - correct name for, 47
 - as feature of Hindu-Arabic number system, 36, 45
 - history of, 45
 - origin, 34
 - properties to assist learning number facts, 59