

# Index

- active learning  
  challenges, 35  
  need for, 34  
  pedagogical approach, 34–35
- adaptive reasoning, 25–26
- Al-Khwarizmi, 9
- algorithm, 10
- analytical skills, 35
- anxiety, 73
- arbitrary knowledge, 10
- Archimedes, 9
- Assessment for Learning (AfL), 50f  
  benefits, 49–51  
  challenges, 50  
  classroom culture, 54–55  
  peer assessment, 58–61  
  purpose, 49  
  self-assessment, 55–57  
  using tasks, 51–54
- Association of Teachers of Mathematics (ATM), 80
- barrier to learning, 79
- boxing-in method, 43
- Brahe, Tycho, 11
- Brunel, Isambard Kingdom, 11
- Cartesian coordinates, 10
- class rooms  
  Assessment for Learning (AfL), 54–55  
  digital technology, use of, 104–105  
  effect sizes, 143–148  
  independent learning, 20–21  
  language awareness, 79  
  metacognitive strategies, 74–75
- Cockcroft report, 82
- collaborative work, 42–43, 57, 65, 80, 97, 132
- community of mathematicians, 44, 74–75, 98–99
- Complex Instruction, 98–99
- computer program, 120
- conceptual understanding,  
  25–26
- conversion formula (Celsius and Fahrenheit), 100
- da Vinci, Leonardo, 11
- de Fermat, Pierre, 10
- Descartes, René, 10
- digital technologies  
  challenges, 108–109  
  Mathematics teaching, 110, 125  
  programming, 120–122  
  teacher demonstration, 110–113  
  tools, 113–119
- digital tools  
  dynamic geometry, 112–114  
  graphical calculators, 115, 118–120  
  graphing software, 112, 115–119  
  spreadsheets, 112–116  
  dynamic geometry, 114–116
- effective learning, 132
- effect size, 139, 143, 145–148
- ELISA test, 120
- English as first language (EAL), 88
- Euler, Leonhard, 119
- feedback, 41, 49, 61, 94, 113, 119, 137–138
- first language, 77, 88
- ‘Four Colour’ theorem, 120
- Galilei, Galileo, 10
- global issues, 128–129
- global thinking  
  challenges, 124  
  collaborative work, 132–133  
  data collection, representation and interpretation, 126–129  
  effective participation, 123–124  
  and global issues, 130–132
- need for students, 123
- probability, understanding, 129
- statistical techniques, 125–126
- in teaching mathematics, 125
- Gowers, Tim, 66
- graphical calculators, 115, 118–120
- graphing software, 114, 118–120
- gravitational effects, 10
- group work, 79–81, 97. *See also* collaborative work
- growth mindset, 89, 94–95
- Habits of Mind. *See* thought processes
- Hewitt, Dave, 10, 44
- How to Solve It* (Polya), 69
- inclusive classrooms, 79, 94–95, 99
- inclusive education  
  challenges, 94  
  collaborative working, 98–99  
  digital technologies, use of, 104–105  
  growth mindset, 75, 90, 95–96  
  importance of, 94  
  in mathematics, 95  
  learning environment, 93–94  
  low-threshold, high-ceiling (LTHC) activities, 96–97  
  sharing of ideas, 102–103  
  skills and interests in other subjects, 104–105  
  teaching approaches, 95–99
- independent learners, 34
- knowledge, 9–12, 15, 24, 34–37, 45, 52–54, 63, 73, 108, 131, 140
- language awareness  
  academic proficiency, 78  
  challenges, 79  
  class room dialogues, 80–91  
  group work, 81–82

**Approaches to learning and teaching Mathematics**

- school context, 78
- teacher–student dialogue, 80–81
- whole–class interaction, 80–81
- learning. *See also* active learning; Assessment for Learning (AfL)
  - barriers, 93–94
  - independent, 20–21
  - effective, 132
  - environment, 94–95
- low–threshold, high–ceiling (LTHC) activities, 20, 96–97
- mathematical powers
  - conjecturing and convincing, 36, 40–44
  - imagining and expressing, 36
  - organising and categorising, 36, 45
  - specialising and generalising, 36–40
- mathematical proficiency, 25f
  - adaptive reasoning, 25–26
  - conceptual understanding, 25
  - procedural fluency, 25, 28
  - productive disposition, 25–26
  - strategic competence, 25–26
- mathematical proof, 9–10, 12
- mathematical skills, 12, 36, 46, 94
- mathematical statements, 53–54
- mathematicians, 10–11, 36, 44, 65, 66–69, 71, 75–76, 89, 95, 97–98, 102, 109, 112, 132
- mathematics
  - as compelling subject, 15
  - as process, 11–12
  - classical education, 9
  - foundation to other subject, 10–11
  - history of, 9
  - need for student’s talking, 82–84
- metacognition
  - challenges, 64
  - description, 63
  - purpose, 64
  - thought processes, 65–74
- misconceptions, 54, 80
- mixed–ability teaching, 97
- multiple representations, 17–20
- necessary knowledge, 10
- Newton, Isaac, 10
- Nightingale, Florence, 11
- one–to–one interactions, 81
- Pascal, Blaise, 10
- perseverance, 26, 94
- probability theory, 10
- problem–solvers, 65, 68
- problem–solving process, 11, 17, 37, 45–46, 65–66, 68–70, 72
- procedural fluency, 25, 28
- productive disposition, 25–26
- professional development:
  - challenging, 135, 136–137
  - focus, 135–137
  - pathways, 140
  - sharing, 135, 136–137
- programming, 120–121
- proof by exhaustion, 71
- Pythagoras’ Theorem, 43–44, 112
- questions, asking, 55, 67–70, 75, 89, 125, 127, 131, 149
- reflective cycle, 136f
- resilience, 74, 94
- Rooke, David, 80
- rope model, 24
- selecting sequence of activities
  - number tricks, algebraic expressions, 30
  - pair products, 31
  - perimeter expressions, 29–30
  - proof, justifications, 31–32
- spreadsheets, 112–116
- strategic competence, 25–26
- students
  - additional support, 105
  - digital technology, use of, 112–113
  - engaging, 15, 103–104
  - metacognitive skills, 64
  - peer assessment, 58–61
  - re–vision’ of ideas, 34
  - self–assessment, 55–57
- syllabus, 24, 26
  - planning linked activities, 26–28
  - selecting sequence of activities, 28–30
- teacher
  - active learning, encouraging students, 34
  - AfL classroom culture, 54–59
  - digital demonstration, 109–112
  - idea about student’s capabilities, 90
  - inclusive classroom, 94
  - language awareness, 77–79
  - learning and teaching, 134
  - practical resources, 17
  - problem–solving techniques, 68–69, 72
  - setting metacognitive skills, 69–76
  - student dialogue (why, what and how), 80–89
- teaching
  - Assessment for Learning (AfL) approach, 49–50
  - Complex Instruction model, 98
  - Learning and, 137, 139, 142, 148
  - listening and, 80
  - mathematics, 44–45
  - results–driven environment, 24
  - with digital technologies, 106–120
  - theory of heliocentricity, 10
  - theory–building, 65–66
  - thought processes
    - curiosity, 66
    - determination, 65, 73–74
    - thoughtful, 65, 68–73
  - thoughtful problem–solvers, 69–73
- universal truth, 10
- visual representations, 89
- whole–class interaction, 80–81