

# Index

- abiotic factors, 166
- accountability, assessment for, 129
- agency, 61
- agents of change, 56, 67, 68
- Aikenhead, G. S., 7
- Ainley, J., 20
- Alexander, R., 121
- alternative conceptions, 35, 57, 100, 137, 142, 204, 205, 229
- analogical instruction strategy, 118
- analogical reasoning, 119
- Anderson, D., 186
- Andrews, R.L., 159
- Angus, M., 20
- Appleton, K., 4, 26
- assessment, 128
  - for accountability, 128, 129
    - within science inquiry, 130–2
  - teachers' role in, 140–2
  - See also* assessment for accountability, diagnostic assessment, formative assessment, summative assessment
- astronomy, 82–4
  - NASA, 96
  - See also* earth and space science teaching and learning
- atmosphere, 218
- Australian Curriculum, 5, 92
  - Biological Sciences, 69, 147, 149–50, 166, 167, 168
  - Chemical Sciences, 70, 147, 150–1, 186, 187
  - Earth and Space Science, 69, 147, 151, 209
  - Nature and Development of Science, 103
  - Physical Sciences, 70, 147, 150–1, 187, 227
  - Science as a Human Endeavour, 69, 95, 103
  - Science Inquiry Skills, 70, 95, 101
  - Science Understanding, 95, 187, 227
  - Use and Influence of Science, 103
  - See also* Victorian Essential Learning Standards
- Ausubel, D., 251
- authentic learning, 13–14, 15, 176, 177
  
- Baacke, D., 55
- Barnes, D., 121
- barriers to science teaching, 21–2
  - extrinsic, 27–32
  - intrinsic, 22–7
- barriers to student learning, 32–5
- Berry, A., 4
- Berryman, M., 46
- big ideas, 132, 186
- biology
  - animal functions, 169
  - classification, 168
  - environment, 168, 169
  - life cycle, 169
  - living things, 168
  - non-living things, 168
  - plant functions, 169
- biology learning and teaching, 166–7
  - 5E model, 169–71
  - curriculum requirements, 167–9
- biosphere, 218
- biotic factors, 166
- Bishop, R., 46
- Blair, 68
- Bloom's taxonomy, 123
- boiling point, 192
- Brigham, P., 102
- Bronfenbrenner, U., 55
  - See also* ecological model of child development
  
- Campbell, C., 11, 67
- Carey, S., 175
- Carr, D.L., 159
- Carter, C.C., 159
- Cashman, T., 76
- Chambers, D.W., 92
- chemical elements, 194
- chemistry, 186
  - guided inquiry teaching approach, 186
  - objects, 190
  - properties, 190
  - See also* matter
- citizen scientists, 14–15
- classroom assessment, 132–9
  - purpose for, 128–30
  - support for, 142
- classrooms
  - and community, 47, 67
  - organisation of, 48
- Claxton, G., 92
- closed questions, 123
- Clough, M. P., 105
- co-construction, 31, 122

**Index**

- Colvill, M., 11
- communication  
 modes, 227  
 patterns, 48  
 skills, 12–13
- compass points. *See* geolocation
- concepts  
 canonical forms, 206
- condensation, 58, 217
- constructivist approach to learning and teaching, 169, 229, 251
- Cowie, B., 133
- creativity, nurturing, 10–11
- critical thinking, 12–13
- crowded curriculum, 28–9
- cultural capital, 40
- culturally responsive pedagogical practices, 40  
 examples, 48–51  
 framework for, 45–51  
 teachers' attributes, 47
- culture-based education, 43–5
- curiosity, nurturing, 10–11
- curricula, 96–8  
 and diverse learners, 40–2  
*See also* Australian Curriculum;  
 New Zealand Curriculum
- curricula integration, 146–7  
 benefits, 158–9  
 definition, 146–7  
 issues with, 159–60
- Danforth, P.E., 159
- data collection and analysis  
 first hand data, 67
- day and night cycle, explanation for, 117–19
- deep knowledge, 160
- deficit thinking/theorising, 46
- Dewey, J., 43
- diagnostic assessment, 129–30
- dialogic classroom culture, 122
- diffusion, 195
- digital literacy, 155
- digital natives, 74
- digital stories, 154
- digital technology, 31
- Dimitrakopoulos, C., 4
- diverse learners, 51  
 science curriculum and, 40–2
- doing science, 101  
 versus writing, 34  
*See also* science as process
- drawing  
 understanding forces through, 231
- dynamic body of knowledge, 94
- earth and space science teaching and learning  
 early primary years, 214–18  
 foundation years, 212–14  
 middle primary years, 218–21  
 senior primary years, 221–3  
 socially relevant contexts, 210–11  
 teachers' and students' involvement in, 209–10
- Earth System science model, 218–21
- earthquakes, 222–3  
 teaching resources  
*Primary Connections Earthquake Explorers*, 222
- ecological model of child development, 55  
 ecological techno-subsystem, 55  
 environmental systems, 55
- ecological sustainability, 59
- Education Review Office (NZ), 20
- elaborate phase, in 5E model, 178–80
- electrical currents, 84–5
- Ellis, A., 146
- empowerment, 61
- energy, 227
- engage phase, in 5E model, 171–5
- evaluate phase, in 5E model, 180
- evaporation, 58, 217
- everyday concept formation, 57
- everyday concepts  
 and scientific concepts, 57–8
- everyday science, 56–7
- experiments, 99, 102
- explain phase, in 5E model, 178
- exploratory writing strategies, 124  
*Sesseltanz* (Germany), 124
- explore phase, in 5E model, 175–8
- feedback, effective, 137–8
- Fensham, P.J., 73
- fieldtrips, 36–7
- First Nation peoples, 41
- Fitzgerald, A., 10, 11
- 5E model, 169–71  
 components, 170–1  
 elaborate phase, 178–80  
 engage phase, 171–5  
 evaluate phase, 180  
 examples, 180–2

- explain phase, 178
- explore phase, 175–8
- Fleer, M., 57
- force pairs, 240–3
- forces, 227, 234–5
  - balanced forces and stationary objects, 235–8
  - in everyday life, 230–1
  - in flight, 114–16
  - floating objects, 238–40
  - force pairs, 240–3
  - friction, 243, 244–6
  - gravity, 235
  - and motion, 243–6
  - teacher's prior knowledge of, 228–30
  - understanding, 231–4
  - understanding through drawing, 231
- formative assessment, 128, 129, 132, 137, 138, 141
  - interactive, 134
  - planned, 133–4
- Forret, M., 73
- Fotiades, F., 197
- friction, 243, 244–6
- funds of knowledge, 135
- gardening activities, 68
- gases, 198–9
- generalist teachers, 2
- Generation Y, 74
- geolocation, 219
  - compass points, 219–20
- George, P., 159, 160
- geosphere, 218
- Gilbert, J., 96
- Grammaticopoulou, M., 198
- graphs
  - bar graphs, 114
  - for representing information, 113–14
  - line graphs, 114
- gravity, 235
- guided inquiry teaching approach, 186
- Gunel, M., 111
- Gunter, G., 76
- Gunter, R., 76
- Hackling, M., 122
- Hand, B., 111
- Hart, R., 59
  - Ladder of Participation, 59
- heterogeneous materials, 190
- Higgs boson, 195
- Hoban, G., 140
- Hodson, D., 67, 98, 106
- homogenous materials, 190
- Howitt, C., 11
- Hubber, P., 137, 201, 234, 241
- human activity, and learning, 4
- Humphreys, A., 146
- Hurd, P.D., 96
- hydrological/water cycle, 217–18
  - condensation, 217
  - evaporation, 58, 217
  - infiltration component, 217
  - precipitation, 217
- hydrosphere, 218
- i can animate*, 120
- iGeneration, 74
- igneous rocks, 250
- inclusive approaches to science
  - education, 11
- indigenous peoples, 40, 41, 48
  - a Māori parent's thoughts, 42–5
  - Indigenous elder community member's thoughts, 42
- informal learning, of science, 36
- information and communication technologies (ICTs), 73, 154
  - exploring, 74–6
  - ICT-enhanced learning in science, 76–86
  - position of, 73–4
  - social software, 77
- inorganic matter, 190
- inquiry-based approach, 123
  - Corn and Popping Corn*, 155–8
  - to integrating learning across the curriculum, 155–8
- inquiry-based learning, 76
  - assessment in, 130–2
- inquiry units, 13
- integrated curriculum, 146
- integration literacy, 76
- interactive formative assessment, 134
- interdisciplinary curriculum, 146, 151–5
- International Seismometer Array (ISA), 223
- internet, 74
- intradisciplinary science curriculum, 147–51
- investigation types, 177
  - design, 177
  - fair testing, 177
  - secondary data, 177
  - survey, 177
- IRE (initiate-response-evaluate), 122

## Index

- Jacobs, H.H., 146  
 Jenkins, 61  
 Jewitt, C., 116  
 Johnson, P., 55, 193, 197, 198  
 journaling in science, 124–5
- Kim, M.M., 159  
 Klemmer, 68  
 knowledge  
   definition of, 96  
   for science teaching, 25–7  
   social construction of, 8–10  
 Koehler, M., 75  
 Krajcik, J., 186
- Ladder of Participation, 59  
 Lake, K., 146  
 learning, constructivist view of, 100  
 learning behaviours, 11  
 learning content, 47  
 learning management systems (LMS),  
   internet-based, 77  
   Moodle, 77  
 learning priorities, 48  
 learning styles, 227  
 Lederman, N., 104  
 Lemke, J., 41  
 life cycle, 169  
 light, 85–6  
 liquids, 198–9  
 local environment, use of, 78–80  
 Locke, J., 100  
 Loughran, J., 4  
 Lubben, 67
- Macey, S.M., 159  
*Making Sense of Science* series, 142  
 Mason, R.T., 159  
 materials, 190, 193  
   description of, 190–1  
   heterogenous, 190  
   homogenous, 190  
   *Primary Connections Gripping Gloves*  
   (resource), 191  
 matter, 189  
   animations demonstrating, 198  
   classification, 199  
   ideas about, 188–90  
   inorganic, 190  
   issues in teaching, 204–6  
   organic, 190  
   particle model of, 189, 194–7  
   in primary curriculum, 187–8  
   states of, 198–9  
   teaching, 200–6  
 Matthews, M. R., 105  
 McComas, W. F., 93, 94, 104, 107  
 melting point, 192  
 mental models, 110  
 metamorphic rocks, 250  
 methodology, 31  
 Millennials, 74  
 Mishra, P., 75  
 mixtures, 190, 192, 193  
 Morris, M., 11  
 motion, forces and, 243–6  
*Moviemaker*, 120  
 multi-literacies, 111  
 multimodal communication, and science,  
   110–12  
 Murray, 61  
 myths, about science, 93–4
- nanoparticles, 189  
 National Assessment Program – Literacy and  
   Numeracy (NAPLAN), 129  
 National Education Monitoring Project  
   (NEMP), 32, 129  
 natural disasters, 221  
   earthquakes, 222–3  
   volcanoes, 222  
 nature of science, 103–6  
   as a human endeavour, 41  
 Neilsen, W., 140  
 Net Generation, 74  
 New Zealand Curriculum, 5, 92  
   Living World, 69, 147, 149–50, 166, 167, 168  
   Material World, 70, 147, 150–1, 186, 187,  
   188  
   Nature of Science, 69, 70, 95, 101, 103  
     Communicating in Science, 95, 101  
     Investigating in Science, 95, 101  
     Participating and Contributing, 95, 103  
     Understanding about Science, 95, 103  
   Physical World, 70, 147, 150–1, 227  
   Planet Earth and Beyond, 69, 147, 151, 209  
*Night Diary*, 213  
 Norris, S.P., 7
- Olney, H., 20  
 Olson, J.K., 104  
 open-ended inquiry approach, 179, 201

- open questions, 123  
 openness, in primary science classroom, 11–12  
 O'Reilly, T., 74  
 organic matter, 190
- Palmer, D.C., 146  
 Papageorgiou, G., 197, 198  
 participatory case studies, examples, 61–7  
 particle model of matter, 186  
 pedagogical content knowledge (PCK), 26, 75, 255  
 pedagogy aims to assist student learning, 5  
 perceptions of science and scientists, 35  
 Periodic Table, 194  
 Phillips, L.M., 7  
 physical volcanology, 222  
 physics, 227  
*See also* forces, matter, substances  
 place-based education, 43  
 planned formative assessment, 133–4  
 positive learning environments, 254  
 Post, T., 146  
 practical science, management of, 31–2  
 practical work. *See* science as process  
 practice, reflection on, 26  
 Prain, V., 137, 201  
 precipitation, 217  
 predict, explain, observe, and explain (PEOE), 34  
 predict, observe, explain (POE), 34, 134  
 Prensky, M., 75  
*Primary Connections*, 133, 142, 252  
 primary science, purpose and content of, 5  
 primary science classrooms, 11–12  
 primary science education course, an example, 253–5  
 primary students, attitudes to science, 32, 33–4, 54  
 primary teachers, expertise, 7–15  
 Pring, R., 146  
 process of science, 92, 101  
 productive questioning, 122–4  
 Programme for International Student Assessment (PISA), 129  
 properties. *See* chemistry  
 pseudoscience, 35  
 pure substance, 194
- quadrats, 216, 219  
 questioning, 232  
*See also* inquiry-based approach
- real world events and investigation, links between, 113  
 reduce, reuse and recycle initiatives, 62  
 Reiss, M., 61, 93  
 relationship patterns, 47  
 reliability of assessment, 142  
 representation  
   multiple multimodal forms of, 136–7  
 representation construction approach, 201–4  
 representations, 186, 201  
 respect, in primary science classroom, 11–12  
 revision of scientific knowledge, 98  
 Richardson, W., 46  
 Roberts, D.A., 6  
 rock cycle, 251  
 rocks  
   igneous, 250  
   metamorphic, 250  
   sedimentary, 250  
 role-play, 118, 200
- scaffolding, 213  
 School Innovation in Science Project, 74  
 science  
   as content, 96  
   description of, 94–6  
   as human endeavour, 5–6, 92, 103–6  
   lack of relevance, 33–4, 54  
   myths about, 93  
   as process, 101–3  
   representations of, 3  
   stereotypes of scientists, 35, 93  
   as a way of thinking and acting, 4  
 science, representations of, 112–13  
 science assessments, monitoring quality in, 141  
 science content, 92  
 science discourse. *See* talking about science  
 science education  
   inclusive approaches to, 11  
   relevance and purpose of, 22–4  
 science education domains  
   doing science, 94  
   learning about science, 94  
   learning science, 94  
 science environment, 36  
 science inquiry skills, 102, 188  
 science leadership, lack of, 258

## Index

- Science Learning Hub (website), 102, 252  
 science representation  
   drawing, 116  
   modelling, 116  
 science teaching practice, 28, 37, 47  
   content-based approach, 25  
   effective science learning, 73–4, 111  
   effective science teaching, 111, 248–53  
   transmission-type approach, 25  
 science teaching resources  
   budgeting, 28  
   equipment, lack of, 29–31, 220  
*Science Understanding*, 96  
 scientific concept formation, 57  
 scientific content knowledge, 3, 25, 26, 210  
 scientific inquiry, 29  
   *See also* inquiry-based approach  
 scientific knowledge, 24–5  
   features of, 98–100  
   teaching, 100–1  
 scientific literacy, 2, 7, 106  
   development of, 6–7  
   exploring the meaning, 8–10  
 scientific method, 101  
 scientists, children's view of, 92  
 scientists, views of, 35, 92, 93  
 Scott, D., 36  
 sedimentary rocks, 250  
 self-assessment, 138–9  
 set of methods and processes, science as, 94  
 sharing 'activities that work', 26  
 Shelley, G., 76  
 Shoemaker, B., 146, 147  
 Shulman, L.S., 75  
*Sloumation*, 120, 140  
 Smith, C., 186  
 Smith, K. V., 4  
 social construction of knowledge, 2, 8–10  
 social constructs, 210  
 socio-cultural view of learning, 101  
 socio-scientific issues (SSIs), 61, 97, 98, 103, 222  
 socio-scientific realities, 54  
   sustainability as, 59–61  
 solids, 198–9  
 standardised tests, 43  
*Status and Quality of Teaching and Learning of Science in Australian Schools, The*, 7  
 Stephen, J., 175  
 stream health, 80–2  
 student engagement, 35–7, 40  
 student researchers, 62  
 students  
   as agents of change, 56, 67, 68  
   as citizen scientists, 14–15  
   empowerment of, 61  
   everyday worlds of, 55–6  
   motivation, to learn science, 32–3, 34–5  
   prior knowledge and experiences, 134–6  
   self-assessment, 138–9  
 substances, 190  
   description of, 191–4  
   explanatory models, 194  
   properties of, 194–7  
   state of, 193  
 substantive science discourses, 121  
 summative assessment, 128, 129, 132, 139–40  
 sustainability  
   ecological, 59  
   as socio-scientific reality, 59–61  
   technological, 59  
 tables, for representing information, 113–14  
 talk, and student learning, 136  
 talking about science, 111, 120–4  
   exploratory conversations, 121  
 task sequencing, 133  
 teacher content knowledge. *See* scientific content knowledge  
 teachers  
   assessment practices, 141  
   'bags of tricks', 209  
   beliefs about students, 46, 47  
   pedagogical expertise, 3–4  
   primary teachers, expertise, 7  
   reasons for learning science, 22  
   reluctance to teach science, 4  
   restricted understanding of science, 25  
   scientific knowledge, 24  
   team work, 8, 25–7, 255–7  
 teaching  
   constructivist approach to, 229, 251  
   errors, 216  
 technological pedagogical content knowledge (TPCK), 75  
 technological sustainability, 59  
 tectonic plate movement, 119–20

- Thinking Together* project, 122  
 Tiakiwai, S., 46  
 Treagust, D., 118  
 Trends in International Mathematics and Science Study (TIMSS), 129  
 trust, in primary science classroom, 11–12  
 TWLH chart, 131, 171–2  
 Tytler, R., 11, 137, 201
- Ulu, C., 111
- validity  
   of assessment, 142  
   of results, 31
- Victorian Essential Learning Standards (VELS), 151  
   Arts, 153  
   Design, Creativity and Technology, 153  
   English, 153  
   Health and Physical Education, 153
- visual conventions, 111, 112  
 volatiles, 222  
 volcanoes, 222
- Vygotsky, L.S., 57  
   *See also* everyday concept formation,  
   scientific concept formation
- Waldrip, B., 201  
 Waliczek, T.M., 68, 159  
 water cycle. *See* hydrological/water cycle  
 water wise practices, 61  
 way of knowing, 94  
 Web 2.0, 74  
 whole community approach, 67  
 whole school approach, 63  
 Willow, C., 55  
 Wisser, M., 186  
 wonder walls, 36  
 Wood, R., 73  
 word walls, 172, 191  
 World Wide Web (WWW), 74  
 writing about science, 124–5  
   *See also* journalling in science
- Zajicek, J.M., 68, 159