

Index

- 10 Big Ideas, NSF, 91–92, 251, 253
- 3D dissection, frog, 78
- 3D Gaia platform, 204
- 3D learning, 141
- 3D-printing, 114, 143, 147, 253
 - 3D-printed fossils, 38
 - 3D-printed Megalodon teeth, 39, 254
- 3D viewing of museum collections, 204
- 3D-scanned digitized museum collections, 219
- 5E model, lesson planning, 143
- 95 percent solution (informal education), 160, 163
- A Framework for K–12 Science Education*, 139
- AAAS. *See* American Association for the Advancement of Science
- academic seminar, 44
- academic, tenure track job, 157
- Adobe Connect, 195
- Advanced Placement (AP), 151, 158, 206
- African-Americans, 113, 114
- After8thtoEducate, 110
- Alachua Astronomy Club, 174
- Alberts, Bruce, 222
- altmetric score, 58, 64–65, 67
 - score weights, 64
- amateur, negative connotation, 192
- amateur paleontologists, 191, 196
- America COMPETES Act of 2010, 28, 256
 - Broader Impacts review criterion, 25
- American Association for the Advancement of Science (AAAS), 11
- American Astronomical Society of the Pacific, 75
- American Indians and Alaskan Natives, 113
- American Museum of Natural History, 164
 - horse evolution exhibit, 166
- American Recovery and Reinvestment Act (ARRA), 85
- Americans with Disabilities Act (ADA), 115
- Anning, Mary, 65
- app development, best practices, 204
- Appalachian State University, GeoBago vehicle, 170
- AR. *See* augmented reality
- Archaeopteryx*, 47, 121
- arXiv, 62
- Asian-Americans, 114
- assessment
 - and evaluation, 209, 237
 - informal STEM environments, 237
 - learning, 237
 - pre- and post-, 237
- Associate degree, community college, 152
- ASTC (Association of Science and Technology Centers), 34
- AstroDance, 56
- astronomy, 192
- Atomic Age, 3
- Attenborough, Sir David, 202
- audiences, 46, 136, 252
 - bilingual (English, Spanish), 99
 - blended, 100
 - Broader Impacts, 211–212
 - complexity, heterogeneous, 106
 - cyberenabled, 100
 - demographics, 103, 253–254
 - description, 94
 - different from ivory tower, 254
 - face-to-face, 100
 - Florida Museum of Natural History, 98
 - formal, structured, 94
 - informal, 96
 - intended, 94
 - international, 97
 - K–12, 95
 - knowing your, 94
 - marginalized, 109
 - multicultural, 97
 - multilingual, 99
 - non-formal, 96
 - non-scientific, 254

- online, 100
- primary target, 95
- public, 97
- trends, Florida Museum of Natural History, 103
- visitors, science centers versus natural history museums, 166
- written narrative, 101
- augmented reality, 205, 206
- authentic research, citizen (community) science, 180
- authors per paper, 69
- authorship, 69–73
 - abuse, 73
 - Contributor Roles Taxonomy (CRediT), 73
 - ethics, 70
 - expectations, 74, 131
 - honorary, 70
 - junior, 72
 - protocols and best practices, 70
 - senior, 72
 - significant contribution, 70
- Barboza, Michelle, 96
- Bard College, 109
- Barnum effect (large size), 83
- bear-dog, Panama, 243
- Bement, Arden, 42, 85
- benefit to society, vii, viii, 147, 149, 162, 209, 252, 256
- bias, definition, 108
- Big Data, 88, 253
- big science, 84
- Billion Oyster Project, 185, 185
- biographical sketch. *See* curriculum vitae (CV)
- Biomuseo, Panama, 211
- bioRxiv, 62
- bison (*Bison*), 89
- Blackett, Patrick, 3
- blended learning, 195
- Bloom, Arthur, 124
- Bloom, Gary, 137
- boilerplate and templates, 249
- Brachiosaurus* (dinosaur), 161
- Brin, Sergey, 151
- broad dissemination, 237
- broadening participation, 132, 152, 249, 257
 - definition, 108
 - underrepresented groups, 120
- broadening representation. *See* broadening participation
 - diversity, and inclusion case study, 112
- Broader Impacts, vii
 - accountability, 255
 - advanced planning and best practices, 212
 - audience, 211
 - audiences, target, 218
 - boilerplate, 210
 - broadening participation, 218
 - budget, 213–214
 - considered as seed money, 214
 - reasonable amount, 213
 - building exhibits, expense, 177
 - can “carry” a proposal, 211
 - choosing activities, 223
 - course, graduate seminar, 156, 162
 - cyberenabled technology, 207
 - Dear Colleague Letter, 2007, 24, 214, 218
 - described in proposal guidelines, 217
 - dissemination, 53, 220
 - evaluation, 223
 - first presented to research community, 30
 - five representative activities, 25, 223
 - Fossil Horses in Cyberspace*, 194
 - higher education, 155
 - INCLUDES, 218
 - indicators of success, 223
 - informal learning environments, 217
 - innovative, 250
 - K–12 education, 217
 - large numbers of people, 223
 - mentoring and role models, 134, 217
 - merit review criteria, 24, 195
 - Next Generation Science Standards (NGSS), 217
 - non-formal presentations, 176
 - part of NSF’s mission, 258
 - partners and consultants, 212
 - plan, 158. *See also* Broader Impacts plan

- Broader Impacts (cont.)
 pop-ups and mobile museums, 170
 presentations and publications, 220
 research infrastructure, 219
 reviewers, 214
 smartphone app, 202
 societal benefit, 258. *See also* benefit to society
 specialized laboratories and major instruments, 219
 strategy, 213
 success, indicators of, 222
 teaching, training, and learning, 217
 training, 158
 underrepresented minorities, 218
 urban or underserved communities, 219
- Broader Impacts 2.0, 26
 Broader Impacts 3.0, 249, 256–257
 Broader Impacts course, 178
 Broader Impacts plan
 ethics of cutting out of budget, once funded, 214
 including disabled, 118
 increased reach via cyberenabled platforms, 197
 integrated early in proposal development, 214
 K–12 mentoring, 127
 Project Description, 212
 underrepresented audience, 119
- Buhi, William (Bill), 183
 Bush, Vannevar, vii, 2, 3, 6, 7, 17, 81, 132, 257
 Butler, Barbara, 86, 159
- C. megalodon*. *See* Megalodon
 CalTeach, 155
 Calvert Marine Museum, Maryland, fossil preparation lab, 168
 Cambridge Science Festival, UK, 173
 Cape Town, South Africa, 49
Carcharocles megalodon. *See* Megalodon
 Cedar Key, Florida, pop-up display, 116
 Cenozoic climate, 143
 Center for Precollegiate Education and Training (CPET), 142
 Center for the Advancement of Informal Science Education (CAISE), 163, 238, 248
 Central Michigan University Herbarium, 88
 Cesar Chavez Middle School, Watsonville, California, 133
 charismatic species, 83
 children
 collecting ants, 179
 collecting meaningful data, 191
 Christiano, Ann, 54
 Chu, Steven, 151
 Cincinnati Museum Center, 33
 citizen and community science, 179, 184
 data quality, 187
 models, 186
 movement, 186
 step-by-step, 186
 citizen scientists
 participation bias, 186
 citizen versus community science, 180
 climate change, 14, 86, 143, 147, 200, 254, 255
 coaching. *See* mentoring
 Coburn, Tom, 16, 23, 26
 code red drill, 136
 collaboration, 69, 251
 K–12 education, 234
 mutual benefit, 74, 233
 networking and sustainability, 251–252
 sustainability, 79
 tips for successful, in research, 73
 college football games, physics, 161
 Columbia University, 124
 comic-cons. *See* pop-culture festivals
 Common Core standards, 140
 communication
 between mentor (supervisor) and mentee (supervisee), 131
 cyberenabled, 253
 effective, 43, 48
 effective, Broader Impacts, 55
 optimizing, 94
 pyramid, 45
 versus dissemination, 43
 written, 101

- communication skills
 - improved from mentoring, 128
- community (citizen) science, 178, 179. *See also* citizen and community science
 - data used in peer-reviewed publications, 192
- community colleges, 152
 - benefits, 152
 - dual enrollment, high schools, 152
 - underserved minorities, 152
 - vocational and technical training, 152
- Community of Practice (CoP), 75, 76, 186, 198–199, 253
 - attributes, 198
 - challenges of online component, 198
 - face-to-face environments, 198
 - FOSSIL project, 200
 - online learning and social networks, 198
 - theoretical model, amateur and professional paleontologists, 199
- computer age, societal effect, 207
- Conant, James B., 17, 19
- Connected Science Learning*, 97, 163
- Coons, Christopher, 11
- CoP, 76. *See* Community of Practice
- Cope's Rule, 58
- Córdova, France, 76, 90, 119
- Cornell Lab. *See* Cornell Laboratory of Ornithology
- Cornell Laboratory of Ornithology, 188–190
 - citizen (community) science, 189
- Cornell University, 124
- Coursera, 153
- CPALMS, Florida K–12 standards, 148
- crowdsourcing, 180, 187, 187–190
- CRPA (Communicating Research to Public Audiences), 55
- Curate My Community, 33–34, 161
- curriculum vita (CV), 72
- cyber-, prefix meaning, 85
- cyberinfrastructure systems, 208
- cyberlearning, 195–198
 - advantages and disadvantages, 197
 - breaking, 197
- cyberspace, 194
- cybertechnology, 253
 - downside: technology versus outdoors, 207
- Daddario–Kennedy amendment, 22, 82
- dark data, 253
- Darwin exhibit, 98
- data collecting
 - children, 191
 - citizen (community) scientists, 190
 - non-professionals, 191
- databases
 - scaffolding learning, 206
- Deep Time, 7, 147
- DeSena, Al, 93
- digital divide, 202
- Dino-Day, O'Hare Airport, Chicago, 161
- dinosaur (*Brachiosaurus*) skeleton, 162
- dinosaur hall, American Museum of Natural History 1929, 119
- dinosaurs, 83
 - on display in airports, 161
 - MOOC, 154
 - in science centers, 166
- discrimination, definition, 108
- dissemination
 - and communication, 252
 - kinds, examples of, 53
 - mass media (print and broadcast), 221
 - museum exhibits, 220
- diversity, definition, 108
- diversity, equity, and inclusion (DEI), 120
- dominant themes, this book, 250
- donation to children's museum
 - hypothetical scenario, 95
- dumbing down, 254
- eBird, 189, 202
- edX, 153
- El Rito Library, New Mexico, STEM activity, 116
- e-learning, 153, 158
- elevator speech, 42, 55, 252
- Elsevier, 61
- email, adversarial, 227

- employment in science and engineering for
 persons with disabilities, 117
- English as a second language (ESL), 118
- English language learners (ELL), 97, 118
- EPSCoR (Experimental Program to Stimulate
 Competitive Research), 22, 23
- equality, definition, 108
- equity, 107
- equity, definition, 108
- Equus*
 exhibit, xi
 skeleton, zooarchaeology, 20
- evaluation, 189, 211, 236, 248, 255
 assessment, 144
 budget, 255
 cost, 238
 and development, 239
 embraced by educators, 255
 formative, 241–243
 front-end, 240–241
 informal science (STEM) programs, 177
 interviews, 242
 objective feedback, evaluator, 238
 planning up to 10% of direct costs, 239
 process, 240–244
 program effectiveness, 237
 remedial, 243
 start early during proposal
 development, 248
 strategic impact, 255
 success of public participation, 193
 summative, 243
 training, 255
 unanticipated outcomes, 248
 user-friendly guides, 248
 versus research, overlap, 238
 validated instruments, 248
 written reports, 247
- evaluator, 238–239, 240
 external, 238
 where to find, 238
- evolution, 14, 86, 143, 147, 254, 255, *See also*
 theory, evolution as
 acceptance, 247
 course at UF, 246
 creationism, 200
 fossil horse, 87
 understanding versus acceptance, 247
- exhibits, expensive to build, 169
- Explora* science center, Medellín,
 Colombia, 98
- Exploratorium, 3, 166
- Facebook, 64, 199, 208, 209
 older people, 100
- fad trend (hype cycle), 153
- Fifty-Minute Hour*, 44
- Flatow, Ira, 176
- Florida Comprehensive Assessment Test
 (FCAT), 139
- Florida Museum of Natural History
 30-day engagement period of “visitors,”
 2018, 105
 attendance (visitation), since 1939, 104
 Butterfly Rainforest, 167
 graphic panel, Butterfly Rainforest, 50
 Canoes bilingual exhibit, 98
 Centennial Live Lab on display, 168
 cyberimpacts, multiplying effects, 209
 Dickinson Hall building, 20
Fossils4Teachers, 218
 McGuire Center for Lepidoptera Research
 collections, 220
Megalodon exhibition, 215
 mobile museum (Florida State
 Museum), 170
 physical visitors versus cybervisitors, 207
 public event, 175
 science at brew pub, 175
 shark exhibit, evaluation, 240
 visitor demographics, 98
 visitors with disabilities, 115
 volunteer leading tour, 182
 volunteers, 182–184
 website, 194
- Florida State Museum. *See* Florida Museum of
 Natural History
- foraminifera, 57
- formal educational continuum, K– 16, 151
- fossil clubs, 94

- presenting talks to, 215
- fossil databases (e.g., Paleobiology DataBase), 206
- fossil digitized specimens, 253
- fossil festival, 94, 254
- fossil horses (Family Equidae), 94
 - displays in museums, 143
 - distribution map using GBIF, 207
 - evolution, 142
 - K–12 lesson planning, 142
 - outmoded exhibits, 165
 - Parahippus leonensis*, 143
 - teeth, geochemistry, 254
 - web searches, 86
- Fossil Horses* book, 101, 124
- Fossil Horses in Cyberspace, 86, 106, 159, 194
 - Google analytics, web traffic, 86
 - website, 87
- Fossil horses, evidence for evolution and exhibits, 47
- FOSSIL project, 16, 200–201
 - cyberenabled network (CoP), 200
 - evaluation, front-end, 240
 - growth of community, 201
 - impacts, 246
 - social media dominance of CoP, 200
 - social media impact, 208
- fossils, 147, 199, 254
 - charismatic, 57
- Fossils4Teachers!* professional development, 218, 248
 - Florida Museum of Natural History, 218
- free-choice learning, 97, 160, 169, 177
- GABI RET (Great American Biotic Interchange Research Experiences for Teachers), 129–130, 146, 147, 245
 - challenges, 146
 - evaluation, cohorts, 244
 - evaluation, expected outcomes, 128
 - evaluation, summative, 244
 - metrics and products, 146
 - summative evaluation, 146
 - summit, New Mexico 2017, 146, 244
- Gallup poll, evolution, 15
- Gantt chart, 229, 231
 - hypothetical project, 230, 235
- gateway science and charismatic STEM, 254–255
- genetically modified crops, 222
- genetically modified foods, 12
- genetically modified organism, 200
- geolocation (latitude and longitude) tool, 202
- Geological Society of America, RISE program, 112
- geological timescale, 206
- Geology*, 48
- Ghost Ranch, New Mexico, 146
- Global Biodiversity Information Facility (GBIF), 89, 188, 189, 202, 206
- global change, 87
- global competence, 10
- global warming, 14, 87
- GMO. *See* genetically modified crops, genetically modified foods, genetically modified organism
- God, created humans, 15
- Golden Fleece Awards, 16, 23, 26
- Golden Gate Bridge Welcome Center, California, 174
- gomphotheres, 66, 170
- Google Scholar, 62
- Gould, Steve, 58
- graduate education, crisis, 157
- Graduate School Mess, The*, 157
- graduate seminar
 - Broader Impacts, 43, 82, 112, 156
- graduate students
 - Broader Impacts, 156–157
- Graslie, Emily, 197
- Great American Biotic Interchange (GABI), 46, 128, 145
- Greenstein, Gerald, 122
- Hall of Florida Fossils, xi
- high-Hispanic-enrollment institutions, 113
- h-index, 63
- Hispanics and Latinx, 113
- historically black colleges and universities (HBCU), 113

- Hollister, Ryan, 204
homeless population, United States, 110
horse (*Equus*), 89
horse family (Equidae), 47
hot-button topics, 13, 15, 86
human fossils, 83
human subjects, research (IRB), 239
- i-10 index, 63
ideation, 32
iDigBio, 77, 88, 225, 226
iDigFossils, 147
inappropriate behavior in professional societies, 112
iNaturalist, 188, 191, 202
INCLUDES, 90
 one of NSF's 10 Big Ideas, 257
inclusion, 107, 108
individual development plan (IDP),
 postdoctoral fellows, 131
infographic, 51–52
informal learning, 163
 assessment, 160
informal science (STEM) institutions
 designed spaces, built environment, 167
informal science education, 160
informal STEM, 164
 education, 181
 learning, 161
Informal STEM Practice Course, 150, 155,
 195, 196
innovation, 30, 33
 definition of, 31
 synonyms, or similar words, 31
innovation and opportunity, 250–251
innovative Broader Impacts, 250
Instagram, 200, 208
Institute of Museums and Library Services
 (IMLS), 163
institutional commitments, 232
Institutional Review Board (IRB), 103, 148,
 239–240
 approvals, 239
integration, 38–38
Intellectual Merit and Broader Impacts, 257
interdependency, sustainability, and project
 management, 226
International Geophysical Year (IGY), 19, 84
internet, 253
IRB. *See* Institutional Review Board
ivory tower, 7, 94, 123
- Jaramillo, Carlos, 137
jargon, scientific, 45
Johnson, Lyndon B., 21
Johnston, Daniel, 133
Jona, Kemi, 76
Jones, Lisa, Watkins Elementary School,
 Washington, 219
journal impact factor, 59
 DORA (Declaration on Research
 Assessment), 60
Journal of Biogeography, 57
Journal of Paleontology, 59, 101
Journal of Vertebrate Paleontology, 59
journals, peer-reviewed
 high impact, 60
 impact factors, 59
 low impact factor (< 5.0), 59
 paywall, 61, 62
junior colleges. *See* community colleges
Jurassic Park, 102
- K–12
 audiences, 136
 audiences, after school and science
 fairs, 149
 Billion Oyster Project, 187
 Broader Impacts activities, 148
 classroom (“role model”) visits, 128
 classroom visits and STEM content
 lessons, 138
 community science, 187
 cyberlearning and SKYPE, 196
 curriculum development, 144
 divide between higher education, 137
 embedding scientists, 149
 engagement, successful activities, 199
 formal education, 137
 fundamental entitlement, 160

- importance of student achievement, 148
- lesson plans, aligned to NGSS, 147
- number of students, teachers, and schools
 - in United States, 137
- outreach, 137
- partnerships, 147
- statewide standardized tests, 139
- student achievement, 160, 237
- “teach to the test,” 139
- teaching and learning, 141
- role of informal STEM institutions, 155
- terms and concepts, 138
- value in US society, 137
- K-12 partnerships, 217
- K-12 teachers, 127
 - motivations and culture, 143
 - needs and expectations, 141
 - professional development, 142
 - volunteers assisting, 181
- K-16 formal education, United States, 151
- Kardashian, Kim, 65
- Kennedy, John F., 22, 184
- K-index, 65
- knowledge, useless, 6
- KSBW, TV station (California), 66
- Lapworth Museum of Geology, University of Birmingham, 168
- late Pleistocene Megafaunal Extinction, 89
- leaky pipeline, 111
- learning
 - formal, K-12, 96
 - free-choice, 96
- learning communities, 198
- learning during a person’s lifetime, 160
- learning research, 144
 - misconceptions, scientists, 248
 - partnering with science educator, 248
 - qualitative, quantitative, or mixed methods, 237
 - systematic sampling methodology (design), 237
 - testing hypotheses, 237
 - theoretical or conceptual framework, 237
 - validated instruments, 237
- learning styles, 51
- lecture format, in colleges and universities, 44
- Leshner, Alan, 76
- lifelong learners, 96, 160, 177
 - barriers, 118
 - as citizen and community scientists, 186
 - lack of diversity, 187
 - motivation, 186
- Lindberg, Erin Peterson, 66
- LinkedIn, 78
- Linnaean hierarchy, 206
- Logansport (Indiana) Youth Correctional Facility, 109
- logic model, 239
- Los Alamos Science Fest, New Mexico, 172
- Los Angeles, California, 35
- Lucky, Andrea, 178-179
- MacArthur Fellowship Genius Award, 117
- MacFadden, Bruce, 125
- Madden, Jill, 133
- magazines, declining sales in United States, 102
- mammoths (*Mammuthus*), 89
- Man: A Course of Study (MACOS), 23
- management plan, Panama PIRE project, 224
- Martian, The*, movie, 102
- mass media, informal science education, 177
- massive open online course. *See* MOOC
- mastodons (*Mammut*), 35, 89
- McKenna, Malcolm C., 124
- McNutt, Marcia, 151
- media, traditional (TV, film, print, radio), 103
- Megalodon, 83, 116
- Megalodon exhibition, 38, 57, 215, 241
 - evaluation, front-end, 241
 - formative assessment, graphic panels, 242
 - map of venues, 216
- mentee, as novice, 122
- mentoring
 - academia, 121
 - continuous process, 126
 - K-12 teachers, value of, 127
 - mentors, 121-123
 - online communities, 122

- mentoring (cont.)
 - peer, 122
 - small group, 122
 - style, 126–127
 - women, postdocs, and minorities, 123
- mentors
 - as expert, 122
 - good qualities, 127
 - not friends, or surrogate parents, 122
 - supervisor, 122
 - unanticipated benefits, 127–130
- metrics and outputs, project, 246
- micro-CT scanners, 253
- Milwaukee Public Museum, Sense of Wonder exhibition, 165
- Miocene
 - fossil display, Montbrook Florida, 222
 - fossils, 66
 - Panama, 243
- misconceptions, controversial science topics, 247
- MIT (Massachusetts Institute of Technology), 153
- mobile museums, 169
- mobile smartphone applications (apps), 204
 - user demographics, 202
- Montbrook fossil site, 170, 182, 183, 222
 - volunteers, 182
- MOOC.
 - large enrollments, 153
 - retention and completion rates, 153
- Moonshots, 184
- Moran Sean, 116, 171
- Morphosource, 77
 - downloads, Florida Museum of Natural History Herpetology, 221
- motivation to visit museums and science centers, 169
- museum label transcription blitzes, 188
- museum visitation models, 104
- museum visitors
 - demographic trends, United States, 97
 - “streakers, strollers, and studiers,” 50
 - time-tracking studies, 49
- Mussetter, Rebecca, 66
- myFOSSIL app, 203
- NABI (National Alliance for Broader Impacts), 26, 76
- Nadkarni, Nalini, 109
- National Academy of Sciences, 31, 38, 70, 122, 125, 139
 - 100th anniversary address, President Kennedy, 22
- National Association of Black Geoscientists (NABG), 113
- National Audubon Society, 75, 189
 - Christmas bird count, 179
- National Park Service (NPS), volunteers, 181
- National Parks, United States, 167
- National Postdoctoral Association, 131
- National Science Board (NSB), 19, 37
 - selection criteria for proposals 1974, 22
- National Science Foundation (NSF). *See* NSF
- National Science Teaching Association (NSTA), 143
- Natural History Museum of Los Angeles County, California, 189
- Natural History Museum, London, 164, 202
- natural history museums
 - annual visitation, United States, 161
 - exhibits, expensive to build, 164
 - visitation, 2005, 96
- natural history specimen data (digitized), 88
- natural philosophy, eighteenth century, 13
- Naturalis Biodiversity Center, Leiden, 165
- Nature*, 48, 59
- nature of science (NOS), 167
- needs assessment, 241
- Netflix*, 102
- network, sustainable, 79
- networking, 69
 - as part of collaboration, 251
- New England Journal of Medicine*, 59
- New Rochelle, New York – country club, 123
- New York Hall of Science, 99
- New York Historical Society, open collections, 168

- New York Times*, 202
- Next Generation Science Standards (NGSS),
 38, 139
 impact more than half of US K–12
 students, 140
 implementation map, by state, 140
- Niederdorfer, Wilhelm, 124
- NIH (National Institutes of Health), 28, 82
- Nixon, Richard M., 22
- No Child Left Behind Act, 139
- non-formal science education, 172–175
- non-traditional venues, 177
 informal science, 172–175
- NSF (National Science Foundation)
 10 Big Ideas, 91, 206, 257
 accomplishment-based renewal
 (ABR), 234
 ADVANCE, 119
 Advanced Technological Engineering
 (ATE), 152
 Advancing Informal STEM Learning
 (AISL), 163
 American Recovery and Reinvestment Act
 (ARRA), 85
 basic research, 83
 BIO Directorate, 77
 broadening participation, future
 priority, 135
 Broader Impacts. *See main entry*
 budget, 1951 to 2019, 21
 Climate Change Education Partnership,
 87
 Communicating Research to Public
 Audiences (CRPA), 86
 Community College Innovation Challenge
 (CCIC), 152
 competitive proposals, 107
 culture of
 evaluation and accountability, 255
 investments in research and
 education, 224
 Dear Colleague Letter 2007, 40, 120
 direct impact on people, 257
 Division of Graduate Education (DGE),
 151
 Division of Undergraduate Education
 (DUE), 151
 DRK–12 program, 144
 early history, 16–20
 Education and Human Resources
 Directorate (EHR)), 42, 130
 first year grants awarded, 1952, 17
 GK–12 program, 149
 Graduate Research Fellowships (GRF), 83,
 91, 151
 Grand Challenges, 91, 206
 higher education, 151
 Human Resource Development (HRD),
 90, 119
 INCLUDES, 90, 91, 107, 123, 132, 257
 increasing accountability, 255
 Informal Science Education (ISE), 85,
 93, 159
 supplements, 215
 Intellectual Merit, 24
 IRB approval requirement, 240
 iTEST, 146–147
 Math and Science Partnerships (MSP), 85
 merit review criteria, 24
 National Research Traineeships, 158
 Noyce Scholarship program, 85, 150, 155
 number of proposals received 2019, 257
 OISE (Office of International Science and
 Engineering), 36, 84
 panels and panelists, review, 211
 Partnerships for International Research
 and Education (PIRE), 91
 postdoctoral mentoring plan, 131, 132
 project description, 213
 projects, multidisciplinary, 251
 Proposal & Award Policies & Procedures
 Guide (NSF 17–1), 25
 proposal guidelines, early years, 18
 review criteria, 256
 review panels, 256
 success rates, 250
 returned without review, 213
 proposals funded, 1952, 19
 proposals, higher probability of
 funding, 251

- NSF (National Science Foundation) (cont.)
 Public Law 81-507, 1950, 17
 RCN, (Research Coordination Network), 76
 renewals, 234
 Research & Related Activities (R&RA), 211
 Research Applied to National Needs (RAAN), 82
 REU programs, 158
 review criteria, 214
 review panel dynamics, 150
 social, behavioral, and economic sciences (SBE), 27
 Science Masters Program (SMP), 85
 Science, Engineering, and Education for Sustainability (SEES), 90, 225
 Small Grants for Exploratory Research (SGER), 35
 single-investigator projects, change from, 251
 Science and Technology Program (STC), 31
 strategic initiatives, 87
 “summer from hell” (2009), 85, 93
 sustainability, 225
 Thematic Collections Network (TCN), 77
 transformational science, 235
 Tribal Colleges and Universities Program, 152
 Vietnam era, 22
 workforce development, 83
- NSF-funded research
 diverse workforce development, 222
 relevance to the “person on the street,” 221
- Nye, Bill, 58, 200, 208
- Obama, Barack, 64
 Opdyke, Neil, 124
 open access (OA), 60–62
 publications costs, 61
 open exhibits, “back-of-the-house” on display, 167
 open storage, visitors, 167
 OpenCourseWare, 153
- Oppenheimer Frank, 3
 Oppenheimer Robert, 3, 166
 opportunity costs, for public engagement, 193, 250
 ORCID, 79
 Oregon State University, Free-Choice Learning, 160
 ornithology, 192
 orthogenesis, 165
 outcomes and impacts, 246–247
 oVert TCN, 77, 78
 Oxford Museum, main exhibits gallery, 165
- Pajaro Valley Unified School District, Santa Cruz County, California, 143
Paleobiology, 58, 59
 Paleobiology DataBase (PBDB), 89, 206
 Paleontological Society Medal, 117
 paleontologist, 192
 amateurs and professionals, 199
 paleontology, xii, 83, 94, 125, 133, 147, 192, 199, 254
 Big Data, 89
 Panama, 57
 fossil horse, 171
 fossils, 29, 37, 46, 211
 teachers collecting fossils, 138
- Panama PIRE Project, 36, 37, 84, 195, 211, 224, 236
 “boots-on-the-ground” fossil collecting, 243
 Broader Impacts plan, 211
 external advisors, 242
 formative evaluation, 242
 institutional contribution, 232
 K-12 teachers, 145
 management plan, 245
 SMART goals, 245
 parachute science, 242
 paradigms, scientific, 247
 Paris Gallery of Paleontology and Anatomy (Cuvier’s Cabinet), 165
 partners and stakeholders, 233
 partnerships
 building trust, 212

- Partnerships for International Research and Educations (PIRE). *See under* NSF
- Paul, Rand, 27
- Peanut Festival and pop-up, Williston, Florida, 170
- PeerJ*, 61, 62
- people with disabilities United States, 115
- Perot Museum of Nature and Science, Dallas, 166
- Pew Research Center, 11, 87
- PhD
in low demand STEM fields, 131
supply and demand, 9, 149, 157
- Philippine flat-headed frog *Barbourula busuangensis*, 78
- Pimiento, Catalina, 57, 134, 156
- PIOs (public information officers), 66
- PIRE program (Partnerships in International Research and Education), 30
- Pleistocene overkill hypothesis, 89
- Pliocene, 57
- PLoS ONE*, 60
- Pokémon characters, 35
- politicization, evolution and climate change, 192
- Polycom technology, 195
- pop-culture festivals, 34
- pop-ups, 114, 169
promoting rural engagement in science, 170
- Port Chester High School, New York, 121
- postdocs. *See* postdoctoral fellows
- postdoctoral fellows, 123, 131–132
- posters
presentations, 50
tips and best practices, 49
- PowerPoint, 52–53
presentation tips, 53
“slide” presentations, 46
- PPSR, 76 *See also* public participation
- preprint services, 62
- press releases, tips, 66
- prisoners, 109
- Privileged Hands A Scientific Life*, 117
- Proceedings of the National Academy of Sciences*, 59, 72
- professional development (PD), 141
meetings and conferences
standard 15-minute talk, 48
networks, 75
societies, 112
workshops for teachers
- project management, 225–226
communication, 226
cycle, 227
definition, 224
effective best practices, 226
flexibility, 228, 245
iterative improvement, 229
sustainability, 211
- project manager, 226
seven optimal skills, 225
- Proxmire, William, 16, 23, 27
- public interest in science, after World War II, 179
- Public Law 81–507 1950. *See* NSF
- public participation
community engagement, 193
promoted by apps, 202
in science demographics, 192
science and STEM, 178
in scientific research, 179
- publish or perish, 53, 68
- R&D (research and development), 31
- RANN (Research Applied to National Needs), 22, 28 *See also* Daddario–Kennedy amendment
- reach, as impact measure, 209
- Renoe, Susan, 76
- research
basic versus applied, 81
charismatic, 83
collaborations, 73
curiosity versus strategic, 82
- Research Coordination Networks (RCNs), 251
- Research Experiences for Teachers (RET), 37, 46, 128, 145, 244

- Research Experiences for Undergraduates (REU), 37, 145, 251
- ResearchGate, 78, 79
- RET (Research Experiences for Teachers). *See* Research Experiences for Teachers
- REU and RET programs, funding success, 145
- REU (Research Experiences for Undergraduates). *See* Research Experiences for Undergraduates
- rhinoceros, Panama, 243
- risk
 - management, 36
 - related to innovation, 35
- robotics, 143
- ROI (return on investment), 35, 36
- role models, 132
 - Hispanic and Latinx, 133
- role models and school visits, 133–134
- Romer, Alfred S., 58
- Roosevelt, Franklin D., 2
- rural underserved communities, 169

- Sagan, Carl, 58
- Santa Cruz California, 38, 46, 66, 98, 133
 - Office of Education, xii, 136
 - sabbatical, 2015–2016, 181
- School of Ants, 178, 179
- science, 48, 59, 101
 - basic, 6
 - delivered by TV, radio, internet, and mobile phones, 114
 - difference from STEM, *vii*
 - public trust in, 11
 - public versus scientists' perceptions, 12
 - strategic, 82
 - value in society, 3
- science and STEM
 - trustworthy source of information, 192
- science café, 176
- science centers, 165
 - exhibits, different from natural history museum exhibits, 166
- science communication, 54, 157
 - effective, 103
- Science Friday*, 102, 176, 204
- science literacy, 13
- Science: The Endless Frontier*, vii, 17, 83, 90, 218 *See also* Bush, Vannevar
- scientific meetings and conferences, 44
- scientific method, 252
- scientific writing and dissemination, 48
- scientist mentor
 - amateurs, avocationalists, and hobbyists, 180
 - benefits, 128
 - traditional stereotype, 110
- self-efficacy, teachers, 147
- Sewell, Bill and Carol, 183
- sexual harassment, 112
- Siegrist, Henry, 124
- Simon, Nina, 169
- Simpson, George Gaylord, 121
- Skinner, Marie and Morris, 125
- Skype, 195
- Skype a Scientist, 253
- SMART goals, 244
 - and meta-goals, 244–246
- smartphones, tablets, and similar devices
 - average daily use, 201, 202
- Smith, Lamar, 27
- Smithsonian Tropical Research Institute (STRI), 29, 137
- social learning networks, 198–199
- social media, 199, 209
 - best practices, planning, and coordination, 201
 - STEM learning, 100
- social responsibility, 1, 94, 134, 207, 256
- societal benefit, vii, 24, 40, 83, 221 *See also* benefit to society
- societal impact, 214
- Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), 113
- Society of Vertebrate Paleontology, 125
- soft skills, 11, 157, 158, 226
- Solar Walk, Gainesville, Florida, 174
- Stafford Creek Corrections Center, Aberdeen, Washington, 110

- Stanford University, 153
- STEAM (STEM plus art), 40
 Academy of the Holy Names, Florida, 39
- STEM, vii, 91
 5E lesson plans, 147
 alternate careers, 157
 broadening participation, underserved communities, 187
 career paths, 111
 careers and college, 133
 charismatic, 254
 code of conduct and ethics policies, 111
 definition of, *vii*
 diverse and inclusive workforce, 133
 employment, 5 percent of
 US population, 178
 engagement, mobile smartphone app, 203
 exhibits, research, 251
 integration, 147
 K–12 education, 13, 38
 learning standards, K– 12, 139
 minorities and women
 underrepresented, 133
 pay disparity women versus men, 111
 postdoctoral fellows in the workforce, 131
 public participation, 192
 role models, 133
 strategic, 82
 underrepresentation of women, 111
 underrepresented minorities, 114
 volunteer workforce, 181
 women, 111
 word cloud, job codes, 4
 workforce, 3, 146
 and jobs, 3, 4
 development, 92
 diversity, 9–10
- STEM learning
 elementary schools, 140
 informal settings, 160
 marginalized, case study, 107
 non-traditional audiences, 109
 nursing homes, 110
 prisons, 109
 YouTube, 200
- stereotype, scientist, 132
- Stifel, Peter, 124
- storytelling. *See* science communication
- strategic impacts, 226, 255
 strategic planning, 226, 228
- Streaming Science, 253
- success, research project, 244
- summative evaluation, 238
 Great American Biotic Interchange
 Research Experiences for Teachers (GABI RET), *See* GABI RET
 post-mentoring gains, 130
 supercomputers and “the cloud,” 206–207
 supervolunteers, 183, 184
Surrounded by Science, 160, 163
 sustainability, 90, 235
 definition, 224
 plan, 235
 pre-award planning, 232
- sustainable network, 80
- synergistic activities, 73
- teacher
 pre-service STEM internships, 155
- teacher professional development
 in-service credits, 141
 “sit and get,” 141
 videoconferences, 196
- teachers, value in US society, 13
- TED Talks, 94, 175
- tenure and promotion criteria, 63
- Texas Advanced Computing Center
 University of Texas in Austin, 208
- theory, evolution as, 45
- three-dimensional (3D) learning *See* Next Generation Science Standards (NGSS)
- Titanoboa* exhibit, Grand Central Station, New York, 172, 173
- titanotheres, 57
- Title I schools, 218
- Trends in Ecology & Evolution*, 48
- Truman, Harry, 17
- Tuatara skull (*Sphenodon punctatus*), 221
- Turlock Unified School District, California, 204

- twenty-first century skills
- twenty-first century technology
- Twitter, 64, 65, 67, 101, 199, 208
- Tyson, Neil deGrasse, 58, 65, 199, 208

- UF Teach program, 150
- underrepresented groups in
 - US population, 114
- underrepresented minorities, 113, 214
 - inner-city populations, 114
- underserved urban minorities, 169
- undocumented immigrants, or displaced people, 180
- University of California, 62
- University of Maryland, 124
- University of Nebraska, football, 161
- USA Science & Engineering Festival, 171–172

- Vermeij, Geerat, 117
- videoconferencing, 195, 227
 - remote participants, challenges, 228
- virtual classroom, 158
- virtual community, 200
- virtual field trips, 204, 206
- virtual fossil digs, 204
- virtual reality, 204, 206
 - and augmented reality, 204
- Visitor Studies Association (VSA), 93, 163, 248
- Visitor Studies, Theory, Research, and Practice*, 93
- volunteers, 180

- Volunteers in Parks program, National Park Service, 181
- VR. *See* virtual reality

- Ward, Wanda, 76
- Wastebook*, 16, 23, 26
- Waterman, Alan T., 19
- Watsonville High School, California, 133
- Web 2.0, 86, 100, 101, 194
- Web of Science, 62
- webinars, 100, 196
 - advance preparations, 197
 - certificates of completion, 197
 - Emily Graslie, 197
- WeDigBio, 188, 189
- Wells, John, 124
- Wilson, Edward O., 151
- Wing, Elizabeth S., 20
- women, in STEM jobs, 111
- word cloud
 - STEM job codes, 3
 - this book, 249
- workforce preparation, community colleges, 152

- Yale University, 117
- youth correctional facilities, 109
- YouTube, 64, 200, 208

- Ziegler, Michael, 134
- Zoom videoconferencing, 195