**Appendix A.** Scientific Content Coding Rubrics

**Supplemental Table 1.** Plants Rubric

**Supplemental Table 2.** Animals – General Rubric

**Supplemental Table 3.** Animals – Fossils Rubric

**Supplemental Table 4.** Matter Rubric

**Supplemental Table 1.** Plants Rubric

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| PLANTS DEPICTED: | | | | |
| Content | Primary Text | Auxiliary Text | Graphics | Graphic Text |
| Type of plant |  |  |  |  |
| Plants need sunlight to survive |  |  |  |  |
| Plants need air to survive |  |  |  |  |
| Plants need water to survive |  |  |  |  |
| Plants need nutrients/soil/dirt to survive |  |  |  |  |
| Plants have stems |  |  |  |  |
| Plants have leaves |  |  |  |  |
| Plants have petals |  |  |  |  |
| Plants have roots |  |  |  |  |
| Plants have seeds |  |  |  |  |
| Plants come from seeds |  |  |  |  |
| Plants can grow |  |  |  |  |
| Plants can die |  |  |  |  |
| Plants can be different colons |  |  |  |  |
| Plants can grow in grass |  |  |  |  |
| Plants respond to environmental changes (i.e. trees’ leaves shed in the fall, flowers’ petals bloom in the spring, etc.) |  |  |  |  |
| Plants reproduce through pollen, seed distribution, etc. *(2nd)* |  |  |  |  |
| Water cycles among land and atmosphere, including precipitation through clouds *(2nd)* |  |  |  |  |
| Incidental content |  |  |  |  |
| Personal language |  |  |  |  |
| Incorrect information |  |  |  |  |
| Accurate adjective doesn’t fit elsewhere: |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ANIMALS DEPICTED:** | | | | |
| **Content: Animals** | **Primary Text** | **Auxiliary Text** | **Graphics** | **Graphic Text** |
| Animal name ⇄ class |  |  |  |  |
| Scientific name |  |  |  |  |
| Animals need air/oxygen to survive |  |  |  |  |
| Animals need water to survive |  |  |  |  |
| Animals need food to survive |  |  |  |  |
| Animals eat plants, fruits, nuts, seeds, and other nonliving things |  |  |  |  |
| Animals eat/feed off other animals |  |  |  |  |
| Animals can be predators and/or prey and are part of the food chain |  |  |  |  |
| Animals have distinguishing features:  Mammals – warm-blooded; have fur/hair, live births, mammary glands; nurse  Amphibians – cold-blooded; have moist skin, have both gills and lungs; have webbed feet; lay many eggs; are born in water  Reptiles – cold-blooded; have dry, scaly skin, either four legs or no legs; lay leathery eggs; are born on land  Fish – cold-blooded; have scales, gills; lay many eggs  Birds – warm-blooded; have feathers, wings, beaks, 2 legs; hatch from eggs  Arthropods – have exoskeletons, segmented bodies, more than four jointed limbs, no backbones |  |  |  |  |
| Compare/contrast of characteristics of species to other species |  |  |  |  |
| Compare/contrast of characteristic variety within species |  |  |  |  |
| Animals have internal structural support |  |  |  |  |
| Animals have body parts that perform specific functions: see; hear; grasp objects; transport; protect from danger; consume food, air, water |  |  |  |  |
| Body part exemplar |  |  |  |  |
| Animals make sounds |  |  |  |  |
| Animals have innate behaviors that they inherit because of evolution and adaptation (i.e. bears hibernating, birds migrating, etc.) |  |  |  |  |
| Animals have learned behaviors that are not inherited that they use to respond to their environment (i.e. deer leaving a forest because of a fire, dogs trained to follow commands, etc.) |  |  |  |  |
| Animals are unique to geographical ecosystems/landscapes/habitats |  |  |  |  |
| Parents engage in behaviors to help offspring survive (i.e. protect, defend, teach life skills, etc.) |  |  |  |  |
| Family structure/community |  |  |  |  |
| Life cycle: birth, maturation, reproduction, death |  |  |  |  |
| Animal species can become endangered |  |  |  |  |
| Animal species can go extinct |  |  |  |  |
| Some animals can be domesticated |  |  |  |  |
| Incidental content |  |  |  |  |
| Personal language |  |  |  |  |
| Incorrect information |  |  |  |  |
| Accurate adjective doesn’t fit elsewhere: |  |  |  |  |

**Supplemental Table 2.** Animals – Rubric

**Supplemental Table 3.** Animals - Fossils Rubric

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ANIMALS DEPICTED:** | | | | |
| **Content: Fossils** | **Primary Text** | **Auxiliary Text** | **Graphics** | **Graphic Text** |
| Fossils defined: prints, indents of a previously living animal/plant |  |  |  |  |
| How fossils created – general: pressed into rock (this goes further than saying it is a print or an indent…needs a general verb) |  |  |  |  |
| How fossils created – specific: one for each aspect of cycle (Animal dies, dirt or something covers it, time passes, becomes stone) |  |  |  |  |
| Bones defined: internal structure, inside a body, under the skin, white, hard |  |  |  |  |
| Fossil examples: animal, person, dinosaur, shells, bones, leaves, stones, food leftovers, sticks/trees, plates, teeth, water life |  |  |  |  |
| Mentioned/defined extinction (must use specific word) |  |  |  |  |
| Fossils specifically named (e.g., name of dinosaur) |  |  |  |  |
| Why fossils useful? Look at things, put bones in the right place, scientists understand them, place in museum, let regular people see them, determine what something was, compare today vs. back then |  |  |  |  |
| Knowledge of fossil when alive: herbivore, carnivore, plant eater, meat eater, size, specific body parts (e.g., plates), function of specific body parts |  |  |  |  |
| When were fossils alive? Timeframe, ancient, long time ago |  |  |  |  |
| Where fossils are found: specific geographic location |  |  |  |  |
| Where fossils are found: materials found in like sand, stone, clay, dirt |  |  |  |  |
| Who studies fossils – general: scientist (only score once even if mentioned multiple) |  |  |  |  |
| Who studies fossils – specific: naming paleontologist (only score once even if mentioned multiple) |  |  |  |  |
| What scientist/paleontologist does? Digs for them, compares them, puts them together, finds them, cleans them, polishes them (must make specific connection between scientists/paleo and their behaviors…vs. why fossils are useful |  |  |  |  |
| Incidental content |  |  |  |  |
| Personal language |  |  |  |  |
| Incorrect information |  |  |  |  |
| Accurate adjective doesn’t fit elsewhere: |  |  |  |  |

**Supplemental Table 4.** Matter Rubric

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SOLIDS DEPICTED:** | | | | |
| **LIQUIDS DEPICTED:** | | | | |
| **GASES DEPICTED:** | | | | |
| **Content** | **Primary Text** | **Auxiliary Text** | **Graphics** | **Graphic Text** |
| Solid ⇄ matter |  |  |  |  |
| Liquid ⇄ matter |  |  |  |  |
| Gas ⇄ matter |  |  |  |  |
| Solid exemplar |  |  |  |  |
| Liquid exemplar |  |  |  |  |
| Gas exemplar |  |  |  |  |
| Texture of material |  |  |  |  |
| Temperature of material |  |  |  |  |
| Color of material |  |  |  |  |
| Properties of solids: hold their shape, don’t flow; can be broken; have specific structure/arrangement of particles |  |  |  |  |
| Properties of liquids: don’t have their own shape; flow; fill the container they’re in; particles are close together and move around |  |  |  |  |
| Properties of gases: some are visible, some aren’t; expand to fill shape of the container they’re in; particles are well separated and move freely |  |  |  |  |
| Other observable properties |  |  |  |  |
| Purpose of the matter/how material interacts with the environment (i.e. gas form of water creates clouds and causes rain) |  |  |  |  |
| Processes cause changes in states of matter |  |  |  |  |
| Changes of state doesn't = loss of mass |  |  |  |  |
| Other states of material: solid/liquid; liquid/gas; solid/gas |  |  |  |  |
| Conductivity of the material (ability to transfer energy) |  |  |  |  |
| Incidental content |  |  |  |  |
| Personal language |  |  |  |  |
| Incorrect Information |  |  |  |  |
| Accurate adjective doesn’t fit elsewhere: |  |  |  |  |

**Appendix B.** Summary Writing Samples

1. **Supplemental Figure 1.** Fossil content generated by a 2nd grade student coded as Complex Complementary Multimodal Text
2. **Supplemental Figure 2.** Animal content generated by a 1st grade student coded as Complex Redundant Multimodal Text
3. **Supplemental Figure 3.** Matter content generated by a 2nd grade student coded as Foundational Multimodal Text
4. **Supplemental Figure 4.** Plant content generated by kindergarten student coded as Unlabeled Visual Text
5. **Supplemental Figure 5.** Animal content constructed by a 2nd grade student coded as Text-Centric Narrative Text
6. **Supplemental Figure 6.** Plant content generated by kindergarten student coded as Labeled Visual Text

**Supplemental Figure 1.** *Fossil content generated by a 2nd grade student coded as Complementary Complex Multimodal Text*

**A close-up of a notebook

Description automatically generated**

**Supplemental Figure 2.** *Animal content generated by a 1st grade student coded as Redundant Complementary Complex Multimodal Text*

**A child's drawing of frogs and frogs

Description automatically generatedA close-up of a paper

Description automatically generatedSupplemental Figure 3.** *Matter content generated by a 2nd grade student coded as Foundational Multimodal Text*

**A close-up of a paper

Description automatically generated**

**Supplemental Figure 4.** *Plant content generated by kindergarten student coded as Unlabeled Visual Text*

**A drawing of a flower

Description automatically generated**

**Supplemental Figure 5.** *Animal content constructed by a 2nd grade student coded as Text-Centric Narrative Text*

**A child's drawing of bees

Description automatically generated**

**Supplemental Figure 6.** *Plant content generated by kindergarten student coded as Labeled Visual Text*

**A child's drawing on a piece of paper

Description automatically generated**