Review
Texas Science TEKS
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1-13-2020

1. *Is the current structure or framework of the kindergarten–grade 12 science TEKS appropriate? If not, what recommendations do you have for organizing or structuring the TEKS?*

There has been some concern that the science standards are discordant with prevailing national standards (e.g., the NAS "Framework" and the Next Generation Science Standards (NGSS)). The organization of scientific study/inquiry can be more effectively taught, say many teachers, by using the structure and the teaching resources of the NGSS. This is a meta-level issue, and my question is whether we can recommend some way of synthesizing TEKS and NGSS to retain the uniformity of the former across disciplines while incorporating the "dinension-domain" structure of the latter, or is the level of integration adequate?

6. *Are the TEKS vertically aligned so that concepts are introduced, elaborated on, and refined across multiple grade levels and students will possess the necessary knowledge and skills to be successful in later grades?*

I am not certain whether 6th graders are mathematically prepared to *understand* or *calculate* vector, velocity, or acceleration required in (b)(8) [page 4]: "(B) identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces;" and "(C) calculate average speed using distance and time measurements."

10. *Are there student expectations that are not essential or unnecessarily duplicative and can be eliminated? If so, please identify by grade level/course and student expectation number.*

In order to reduce the additional instructional time required by adding epigenetics to high school biology (see below), I recommend that (b)(7)(F)(page 3), "analyze other evolutionary mechanisms, including genetic drift, gene flow, mutation, and recombination" be adjusted to eliminate drift, gene flow, and recombination, retaining "mutation" and adding "epigenetics". Gene flow and genetic drift are diminished topics in current research, and their contributions to biodiversity are of less magnitude than mutation and selection.

11. *What other suggestions do you have for ways in which the science TEKS can be improved?*

In the following recommended changes, ~~strikethrough~~ is deletion and recommended additions are in **bold**..

Epigenetics. Despite the growing importance of this topic and its centrality in biological research, arguments against adding it to the TEKS include: a) students have insufficient background to understand the biochemistry of epigenetics, and b) teachers have insufficient background to provide instruction on the biochemistry of epigenetics. However, epigenetics covers a wide range of topics, beginning in 1894 with William Bateson with the beginnings of Evo-Devo. This requires none of the biochemistry of methylation and is readily accessible (see Sean Carroll, *Endless Forms Most Beautiful*, and Neil Shubin's *Your Inner Fish*". This is only a small part of epigenetics, I realize, but it is fascinating to students and

reveals that much evolution occurs without involving gene changes. I am recommending, in this context, the following SE addition to High School Biology (b)(6):

(6) Science concepts. The student knows the mechanisms of genetics such as the role of nucleic acids and the principles of Mendelian and non-Mendelian genetics. The student is expected to:

(A) identify components of DNA, identify how information for specifying the traits of an organism is carried in the DNA, and examine scientific explanations for the origin of DNA;
(B) recognize that components that make up the genetic code are common to all organisms;
(C) explain the purpose and process of transcription and translation using models of DNA and RNA;
(D) recognize that gene expression is a regulated process;
(E) identify epigenetic mechanisms which regulate gene expression, including homeobox genes, environmental factors, and lifestyle;
(~~E~~) **(F)** identify and illustrate **natural** changes in DNA and evaluate the significance of these changes;
(~~F~~) **(G)** predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses, and non-Mendelian inheritance; and
(~~G~~) **(H)** recognize the significance of meiosis to sexual reproduction.

The addition of "natural" to "changes", (F), is to emphasize distinction between mutation, chromosomal aberration, etc. and artificial changes such as producing GMOs.

Climate Change. I am sensitive to the dog whistle effect of these two words. I believe that the issue can be addressed even while avoiding any direct reference. My personal belief is that the climate crisis is too important not to be addressed at all. One way to do this is to focus on the human impact on ecosystems.

The following additions to Grades 3, 5, 7, and 8 TEKS more explicitly address the human role in environmental change. The Grade 8 addition is taken directly from the NGSS (MS-ESS3-5 Earth and Human Activity).

Grade 3: (b)(9) [§112.A. page 11]

(9) Organisms and environments. The student knows and can describe patterns, cycles, systems, and relationships within the environments. The student is expected to:

(A) observe and describe the physical characteristics of environments and how they support populations and communities of plants and animals within an ecosystem;
(B) identify and describe the flow of energy in a food chain and predict how changes in a food chain affect the ecosystem such as removal of frogs from a pond or bees from a field; and
(C) describe environmental changes such as floods and droughts where some organisms thrive and others perish or move to new locations.
(D) identify how human activities have had major impacts on environments and the nature of those impacts, and recognize that human activities can also protect Earth's resources and environments.

Grade 5: (b)(9) [§112.A. page 16]

(9) Organisms and environments. The student knows that there are relationships, systems, and cycles within environments. The student is expected to:

(A) observe the way organisms live and survive in their ecosystem by interacting with the living and nonliving components;

(B) describe the flow of energy within a food web, including the roles of the Sun, producers, consumers, and decomposers;
(C) predict the effects of changes in ecosystems caused by living organisms, including humans, such as the overpopulation of grazers or the building of highways, **or the generation and transmission of power from various sources**; and
(D) identify fossils as evidence of past living organisms and the nature of the environments at the time using models.

Grade 7: (b)(8) [§112.B. page 18]
(8) Earth and space. The student knows that natural events and human activity can impact Earth systems. The student is expected to:
(A) predict and describe how catastrophic events such as floods, hurricanes, or tornadoes impact ecosystems;
(B) analyze the effects of weathering, erosion, and deposition on the environment in ecoregions of Texas; and
(C) model the effects of human activity on groundwater and surface water in a watershed.
(D) identify human activities that affect the biosphere and the climate in regions of Texas.

Grade 8: (b)(10) [§112.B. page 3]
(10) Earth and space. The student knows that climatic interactions exist among Earth, ocean, and weather systems. The student is expected to:
(A) recognize that the Sun provides the energy that drives convection within the atmosphere and oceans, producing winds;
(B) identify how global patterns of atmospheric movement influence local weather using weather maps that show high and low pressures and fronts; and
(C) identify the role of the oceans in the formation of weather systems such as hurricanes.
(D) ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century