ZIMMERMAN INITIAL REVIEW

GUIDING QUESTIONS

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?

- Current structure: grade-level introduction → discipline-based knowledge and skills statement → specific student expectations is appropriate
    - Additionally, through K-5 TEKS the discipline-based knowledge statements are consistently numbered to aide in vertical alignment. A teacher could determine the depth and level at which a concept is taught in previous and subsequent elementary grade-levels from student expectations.
    - Some edits to make scientific investigation and reasoning (process skills) consistently vertically aligned and scaffolded appropriately throughout all science courses would be beneficial.
    - Would like to see addition or rewording of expectations for students to use engineering design and scientific application skills within scientific investigation processes. This could be combined with adjustments to some student expectation action verbs within content TEKS to allow for teachers to implement these skills when most appropriate (example: develop a model to, conduct an investigation to, etc.)
    - If MS TEKS are adjusted to have a better balance of concepts for each discipline (Matter and Energy (Chemistry); Force, Motion, and Energy (Physics); Earth and Space Science; and Organisms and Environments (Biology)) the knowledge statements should be numbered to clearly align with the foundations built in K-5.

- Terminology – including and such as – is explained but may reduce clarity of expectation
    - *Such as* are meant as examples – recommend feedback per teacher use of these examples i.e. are these being utilized more like *including* statements; check usage of examples to add clarity as intended without limiting content exploration
    - *Such as* utilized much more in Elementary and MS expectations – good for examples as instructors may not have scientific background in all disciplines

2. Does each grade level and/or course follow a complete and logical development of science concepts presented within the grade level/course? If not, what improvements are needed?

- Concepts in Middle School need to be reexamined for coherence of sequence within and between grade levels and complexity of concept. Suggestion to rearrange within grade levels for better flow.
    - Also, look at alignment backwards from K-5 and forward to what is needed in HS. Some topics may be sufficiently taught prior thus not requiring much further

elaboration or not needed to be introduced at all at this level if not age appropriate.

- 7th grade – will drive much of the revision to MS TEKS; need more balance to disciplines covered (Chem, Physics, ESS, Bio)

3. Are the core concepts specific to the disciplines of science (e.g., life science, physical science, and earth and space science) adequately addressed across the K–12 TEKS? If not, please identify the discipline and the concepts that are missing.

- Core concepts are addressed – some adjustments needed to alignment needed; see suggestions and teacher feedback
- Human impact on ecosystems needs to be more thoroughly addressed in the life science concepts

4. Do the standards adequately address the broader concepts that cross various science disciplines (e.g., systems and system models, energy and matter, stability and change)?

- Yes.

5. Are there topics that should be eliminated because they no longer reflect current research or practices within the field? If so, please identify.

- See adjustments suggested.

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?

- See comments below – alignment needs to consider cognitive development of students and follow appropriate progression from concrete to abstract concepts and connections
- Elementary – generally good alignment but some changes needed with overly repetitive concepts or progression of increase in depth and rigor needs adjustment
  - 2.5B – compare changed in materials cause by heating and cooling – compare is less rigorous than predict in 1st grade expectation; switch the complexity or eliminate expectation in 1st graded
  - 7A – expectation strand is for students to describe and compare rocks and soil components based on characteristics and to explore processes of soil and sedimentary rock formation → look at the order and complexity in which these concepts are aligned for possible changes
  - 2.8B – could be combined with 1.8A
  - 2.8C – add Sun so that students have foundation to construct models in 3.8C
  - 4.8B – add effect of Sun energy on weather
  - Foundational introduction of Newton's laws needed at this level for forces and motion strand?
- Middle School – intro statement 3 is important – in which SEs is this addressed?
  - MS - statements are numbered differently from Elementary due to additional expectations

  - 6 – emphasis on physical sciences (chemistry – understanding of elements and physical and chemical changes and physics – motion and energy transfer) with some earth and space and life science
    - could introduce force of gravity on objects depend on mass and proximity to align with 6.11A and B
  - 7 – heavy emphasis on life science with some physical sciences and earth and space as concepts align with life science focus; much biological content here; 7.6A, 7.8B, 7.8C – few SE not related to biological concepts
  - 8 – emphasis on earth and space with some physical sciences and life science
    - 8.8C – do students have foundational understanding of electromagnetic spectrum for this SE?
  - Recommend overall adjustment for better balance of core science concepts in Middle School – look closely at vertical alignment and complexity of concept as well as timing for instruction at appropriate level

- High School – subject specific TEKS
  - Bio.6F – dihybrid and non-Mendelian crosses are difficult for students – is there enough foundation to understand genetics and meiosis prior? is this a necessary concept or would better understanding of simple genetics serve?
  - Bio.10B – could these plant concepts be taught sufficiently at a lower grade level?
  - Chem.10G – Arrhenius and Bronsted-Lowry definitions – necessary?
  - Physics.8 – quantum phenomena – what level of understanding is intended for students?

7. Do the high school courses sufficiently prepare students for postsecondary success?

   - HS offers several other Science courses that allow for greater detail, breadth, and depth of concepts (Anatomy, Earth and Space Science, etc.) as well as other levels at which students can take these courses (advanced, AP). Students should be given solid foundation in scientific disciplines and thought processes in K-8 so that they have background needed to select coursework dependent on interests and future goals.
   - Recommend looking critically at the core HS courses that ALL Texas students take to ensure concepts covered meet the postsecondary needs of a diverse population (postsecondary success means different things for various students to include 4yr university, 2yr college, military, workforce certification, or other career path). What topics in the TEKS could be streamlined to allow for more time to explore relevant topics in more depth for true understanding and application?

8. The current K–5 science TEKS encourage districts to devote the percentage of instructional time to classroom and outdoor investigations as follows: kindergarten and grade 1–80%, grades 2 & 3–60%, grades 4 & 5–50%. The secondary science TEKS require districts to devote at least 40% of instructional time to laboratory and field investigations.

   Are these designations and percentages for instructional time appropriate? Do the current student expectations adequately support the instruction?

   - Generally adequate expectations at appropriate level to support time; addition of investigative design expectations or increased level of application would expand opportunities for students to conduct investigations

  - Need to verify that the action of the student expectation aligns with this time recommendation or requirement (i.e. define and recognize – low level vs. investigate and compare – higher level of application)
  - Also need to verify alignment of action verb to concept being taught and cognitive development of students

9. Are the student expectations clear and specific? If not, please give examples of how the language might be improved.

- Recommend examining wording of SEs to ensure that the scope and purpose is clear for the concept being taught
- Recommend aligning any wording changes in HS process skills TEKS throughout courses to include additional HS science courses

- K.9B – living organisms have basic needs – *air* is listed as need for plants but not animals and students at this age would have no understanding of air containing carbon dioxide or oxygen or of the processes of respiration or photosynthesis; additionally the term *nutrients* (meant to address needs for minerals, etc.) can be confusing for students when learning about photosynthesis; suggestion to simplify examples of needs at this introductory level
- 1.9B – interdependence found in various situations such as *terrariums and aquariums or pet and caregiver* – examples given are artificial representations of nature and difficult to determine level of interdependence to be analyzed by students…food sources only? symbiotic relationships? competition?
- 1.9C – evidence of interdependence such as *energy transfer through food chains and animals using plants for shelter* – energy transfer regarding food sources is advanced for first introduction to food chains and example of animals using plants for shelter confuses the use within food chains; reduce level to introduction of food chains and move energy transfer to 2nd grade as it is expanded upon in 3rd
  - Separate animals using plants for shelter to additional expectation that can include human needs and impact on ecosystems
- 1.10C and D – young animals resemble parents and life cycles - align D and examples to be more simplified expansion of C (similar to plants in Kindergarten) – frog life cycle is complete metamorphosis which could confuse C; add expectation to 2nd grade to investigate how young animals do and do not resemble parents and expand 2nd grade expectation to include frog metamorphosis
  - Alternatively, adjust 1.10D as described and eliminate 2.10C to move suggestion for 2nd grade to 3rd 10B (life cycles would not be covered each year); 4.10C might be eliminated
- 2.3C – what a scientist is – need to ensure this does not lead to misconceptions of scientists and their work; suggest to change to how scientists *think* or what a scientist *does* or eliminate wording within statement altogether to focus on exploration of scientific careers
- 2.5A – classify matter by physical properties including *relative temperature*, texture, flexibility, and whether material is *solid or liquid* – eliminate use of temperature as a physical property by which to classify matter and clarify solid or liquid *at room temperature*; can add additional properties such as color and mass
- 2.10B – *compare* how the physical characteristics of plants help them meet their needs such as stems carry water throughout the plant – another example here is useful to clarify comparison

- 3.5A – *ability to sink or float* is relative to solution and shape of object; introduce density here; same issue with wording in 4.5A
- 3.5B – understanding of states of matter as taking shape of container needs to be clarified, ex. sand or gravel when poured in a container could be described as taking the shape of the container; could introduce concept of particulate nature of matter and movement of these particles as determinate of state
- 3.5D – add a solution example of a mixture – sugar or salt dissolved in water
- 3.6A – provide examples
- 3.9C – some organisms thrive and others perish or *move to new locations* – wording leads to misconception that organisms can leave damaged ecosystems to survive
- 4.7C – nonrenewable resources included are fossil fuels but explanation of formation of fossil fuels is taught in 5.7A; students may understand better why fossil fuels are nonrenewable if they know how they formed
- 4.9B – flow of energy through food webs, *beginning with the Sun* – clarify to beginning with producers capturing energy from the Sun
- 5.9B – flow of energy within a *food web* including the roles of the *Sun*, producers, consumers, and *decomposers*; decomposers get energy by cycling matter from all levels back in to ecosystem; wording here can lead to misunderstanding of role of decomposers; could change to flow of energy and matter within an ecosystem
- 6.5B – *recognize* that a limited number of – simple verb – purpose of this expectation? understanding of relative abundance?
- 6.8A – compare and contrast potential and kinetic energy – add relative to an object's position and motion
- 7.5A – *recognize* energy conversion of *photosynthesis* – could this SE allow for deeper exploration of energy conversion while photosynthesis is moved to biological knowledge strand; recognize is also low complexity for students previously learning about plants needing sunlight and water – at this stage could add greater depth of understanding
- 7.7A and B – clarify for instruction
- 7.9B – add future goals and needs of manned space exploration
- 7.10A – remove microhabitats in schoolyards
- 7.11B – *variation within* a population – examples given do not focus on inherited variation within a species contributing to survival; clarify intent of expectation

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.

- K-5 – 4.A scientific tools – inclusion of hot plates at young age is a safety concern; …and materials to support observations of habitats of organisms such as terrariums and aquariums – unnecessary statement as variety of tools that would be used for content taught in grade level is listed prior
- 2.1.B – and then combine the objects to do something they could not do before – introduces 2.5.D which is out of place within knowledge strand but could be used in investigative design strand
- 7.5B – SE has been explored in 4.9B and 5.9B – add to complexity of student understanding or application of energy flow expectation or do not need to repeat
- 7.8B – do not need to be specific to effects on ecoregions of Texas

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

- Addition of investigative design strand or expansion of current scientific problem solving strand to allow for extended inquiry and problem solving using the engineering design process as it aligns with scientific reasoning and the concepts being taught. Foundations of this are present but should be extended and clarified with examples for students to explore aspects of the process especially those related to creating and testing prototypes as solutions to identified problems. These skills would need to be vertically aligned per student age and would allow for additional options for teachers to plan for recommended investigative time.
    - K-5.3 strand could be reworked to address engineering design process by combining some expectations with other scientific investigation and reasoning strands (3.A – clarified and remains, 3.B - making predictions moved to scientific inquiry 2, models moved to tools and models 4, and 3.C role of scientists/history of science clarified and remains)
    - Other grade level expectations adjusted for greater application of engineering design processes to solve problems while researching, demonstrating understanding of, and addressing if possible other influences on scientific problem solving and decision-making (economic, environmental, etc.)
    - Adjustment of some TEKS to include more opportunities to develop and construct understanding using evidence.
    - There is a need for Texas to graduate STEM-literate students to fill current and future professional positions – understanding of and practice using the overarching thought processes that these careers require is necessary. Evidence-based critical thinking and problem solving skills are cornerstone to STEM-literacy and must be developed in students throughout K-12.