Appendix F

Planning for New Science Standards PowerPoint Presentation

Slide 1

Slide 2

Modify to fit your session
Quick overview of the PD no more than a few minutes. Be sure to describe the goal of the PD: Understanding the vision for science education described in the NRC *Framework*.

Slide 3

See the document by the same name on the Nextgenscience.org website

Slide 4

It is very important to distinguish between adoption and implementation.

There are several steps spelled out in legislation that must take place before any standards are adopted by the Arkansas State Board of Education.
Spring 2013
- NGSS Broad-based committee will review the final version of NGSS and their input will be recorded.
- Release of Science Standards FAQs

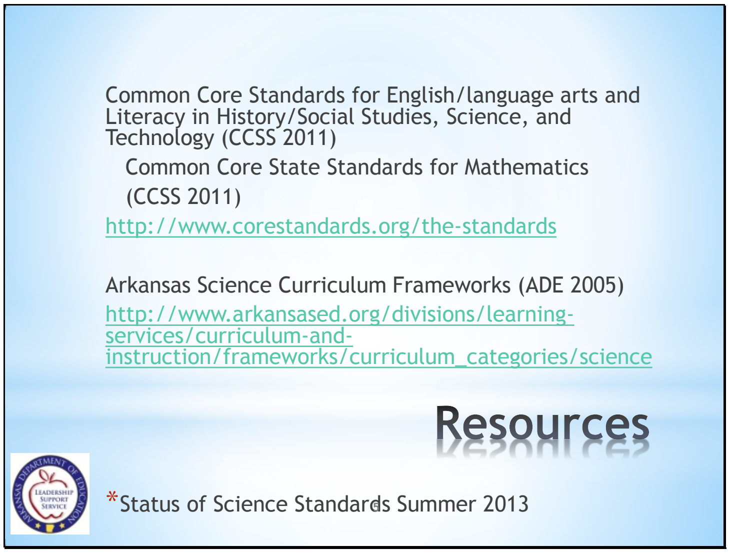
Summer 2013
- State-wide committee of stakeholders will review NGSS and make recommendations to ADE on whether or not NGSS is best for Arkansas
- Cooperative and STEM center specialists will offer PD titled *Planning for Next Generation Science Standards: Understanding the Vision*, a one-day PD
- ADE sends a team to participate in Building Capacity in State Science Education meeting with 40+ states to discuss adoption and implementation of NGSS

Fall 2013
- *Arkansas Science Curriculum Frameworks* will be taught and assessed until further notice
- ADE will review recommendations from the committee and decide the next steps

Could include taking the NGSS to the State Board of Education (SBE), who will make the final decision on adoption of science content standards in Arkansas
- Successful implementation of science standards requires time and careful planning
- Depending on the decision of the SBE, planning for the implementation of new science content standards will then begin

If the State Board chooses to adopt the NGSS as Arkansas's science standards, then an implementation plan will be put into place.
Implementation will be a multi-year process to be determined. It would be presumptive to put out any implementation plan for standards that have not been adopted. If asked whether teachers will be teaching the NGSS standards in 13/14 the answer is NO.
Science Instructional Materials adoption was postponed until 2015.

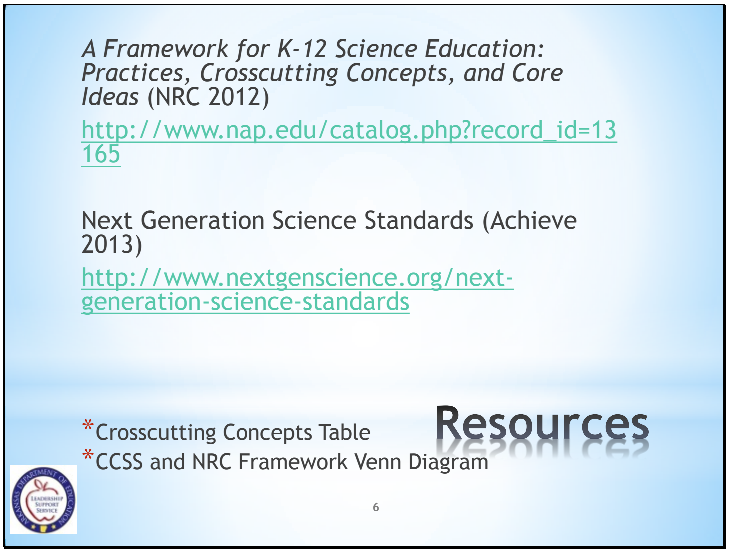
Slide 5



Allow time for participants to go to these websites and download the documents if not already provided.

All documents with an asterisk have been uploaded to **http://arkansasNGSS.pbworks.com**

Slide 6

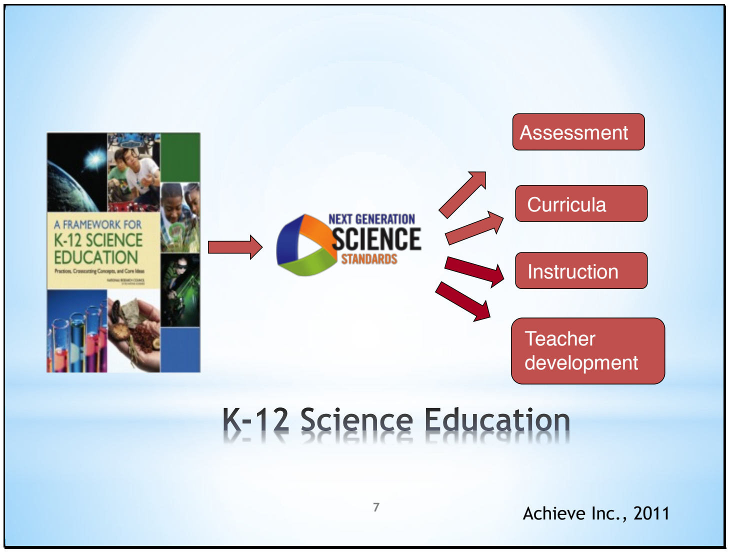


Allow time for participants to go to these websites and download the documents if not already provided. We highly recommend that all NGSS documents, including appendices, be downloaded prior to the workshop.

Documents with an asterisk have been uploaded to **http://arkansasNGSS.pbworks.com**

From here on out please refer to *A Framework for K-12 Science Education* as the NRC *Framework*.

Slide 7

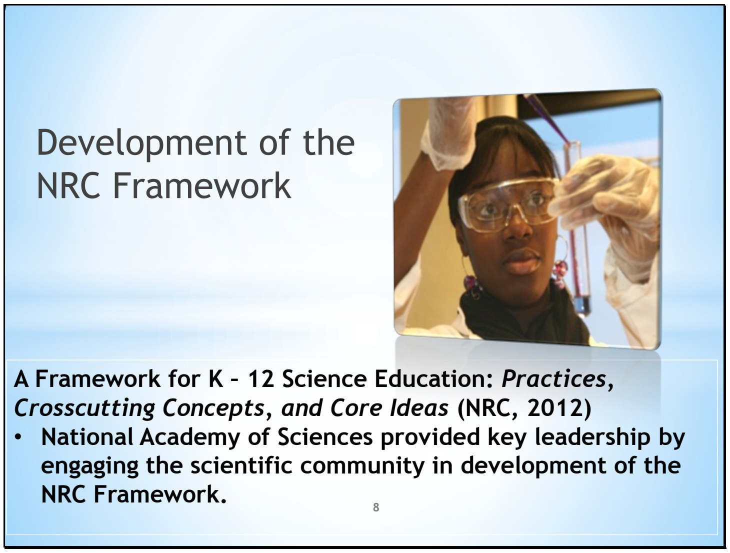


This is an overview diagram of the phase 1: NRC *Framework*, Phase 2: NGSS, and Phase 3 state implementation.
The four components of phase three – assessment, curricula, instruction, teacher development - will come after the adoption process.

With the release of the new *Framework* we are focusing specifically on deepening understanding of core concepts.
The National Academies have the horsepower and wherewithal to provide the framework for clearer, fewer, and better standards.
By focusing on one framework and one set of standards, the scientific and education communities can provide the guidance and expertise to get this right.

The *Framework* informs the standards.
Standards inform Assessment. Curricula, Instruction and Professional development
Standards tell students/teachers what to do
Curriculum is how to teach the Standards
Instruction is what pedagogy is used to teach the Standards
Assessment is how to clarify what students have reached proficiency

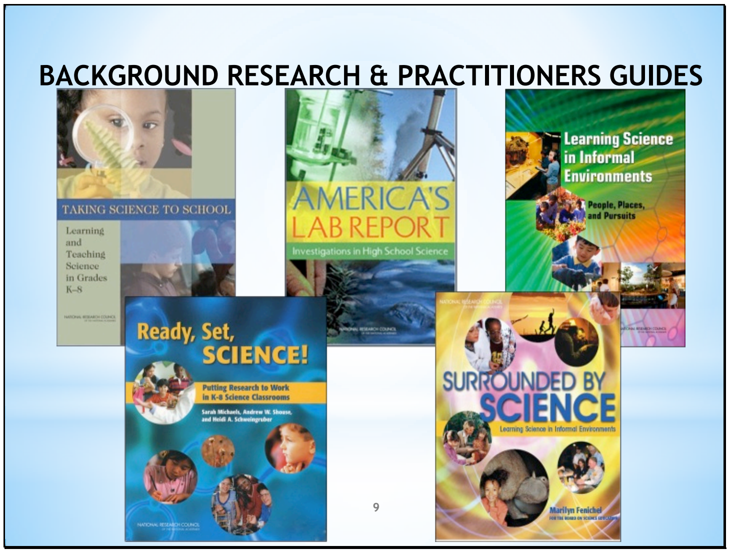
Slide 8



The National Academies is a non-governmental nonprofit institution of various organizations of science: National Academy of Sciences, National Research Council (NRC), National Academy of Engineering, and Institute of Medicine. This was formed by President Lincoln to inform government on matters of science.

NRC wrote the first set of national science standards in 1996.
The NRC (National Research Council) *Framework* is from the scientific community. The guiding principles of the *Framework* are how students learn science, core scientific ideas accepted by the scientific community, the development of understanding over time, the connection between knowledge and practice, student interest and experiences, and the promotion of equity among all learners.

Slide 9



These are the documents of published research on how students learn science that were used to:

- guide the reasoning for the content
- guide the rigor of content
- Appropriate practices/crosscutting concepts at each grade band (K-2, 3-5, 6-8, and 9-12)

Heidi Schweingruber is one of the writers of *Ready, Set, Science* and the NRC *Framework*. She has also been involved in the writing of the NGSS

Slide 10

Turn to the Table of Contents pgs. *vii – viii* (PDF pgs. 8 - 9)

Repeat again:
This is the NRC (National Research Council) *Framework*. It is the foundational document upon which the NGSS are being developed.

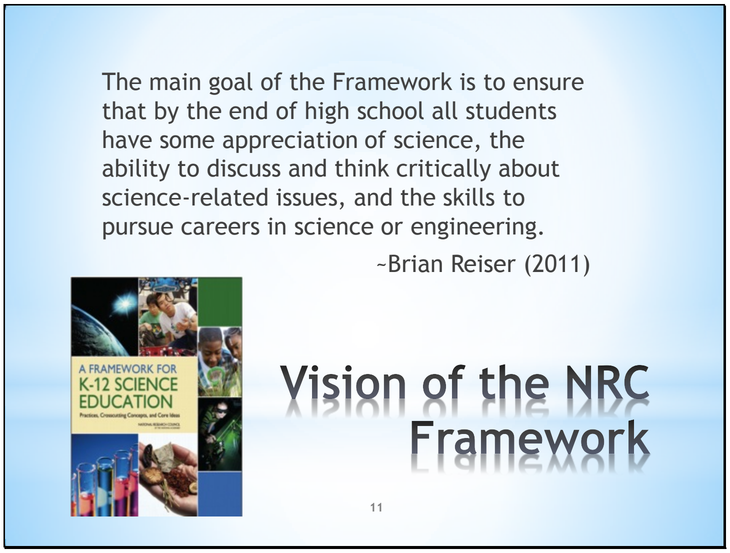
Spend time to teach participants how to read the document
Note how the document pages are numbered in the book versus the PDF

PART I is composed of Chapter 1: vision statement and Chapter 2: Guiding Assumptions and organization of the Framework
Part II is composed of Chapters 3 through 8: 3 dimensions
Part III is composed of Chapters 9 through 13: provides support and guidance in the 3 phases for standards development and implementation.

Appendixes include a summary of the feedback and revision process, a bibliography, biographical sketches and design team members
TODAY we will MOSTLY focus on PART II

Also point out that at the end of each chapter there are references.

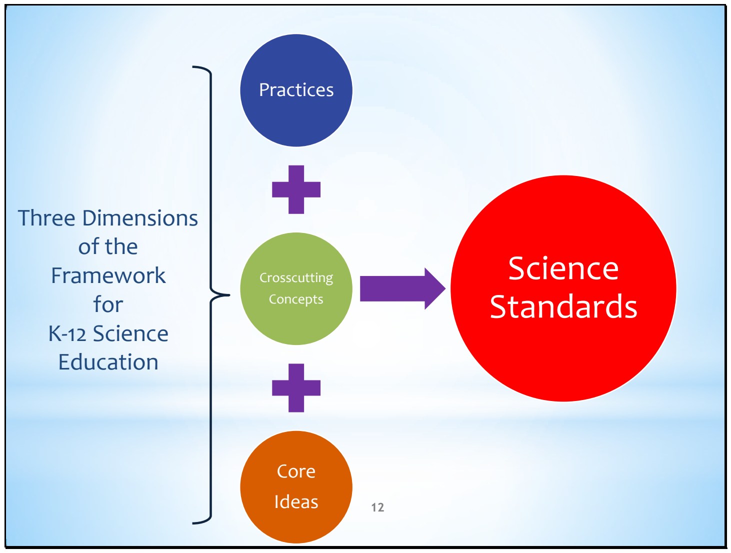
Slide 11



<u>Table of Contents pgs. *vii – viii* (PDF pgs. 8 - 9)</u>
This is Part 1
The main goal of the *Framework*, according to the report, is to ensure that by the end of high school all students have some appreciation of science, the ability to discuss and think critically about science-related issues, and the skills to pursue careers in science or engineering – areas where current educational approaches fall short.

Quoted~ Brian Reiser is one of the writers of the *Framework* and whose research is interested in the use/design of models in life science instruction.

Slide 12

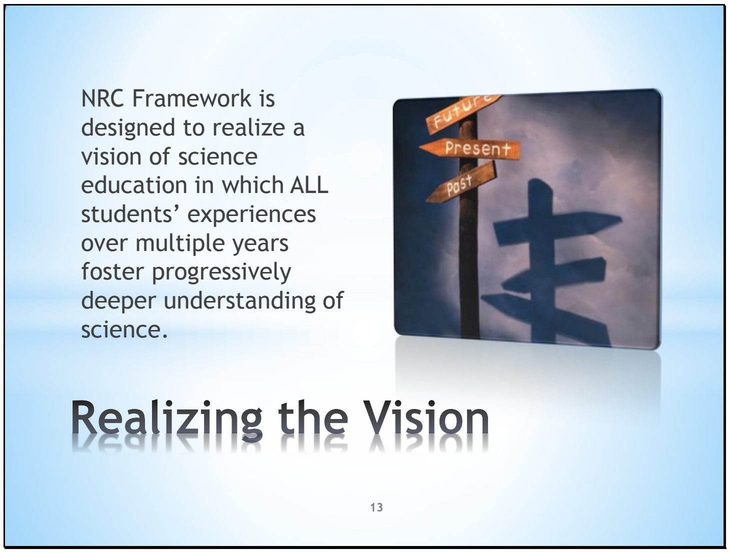


Turn to pg. 3 (PDF pg. 18) and refer to BOX S-1
This is Part 2: the 3 dimensions. This is a BIG Shift. The intent of the *Framework* is to change how we teach science to be more like how scientists work. All science will be taught with the 3 dimensions in concert...

- The Practices
- The Crosscutting concepts
- The Core ideas

Explain how YOU see science teaching being different.
Engage teachers in a discussion about what they might already know about the three dimensions and ask why this is a big shift.
The vision is for students to be actively engaged at the nexus of the three dimensions.

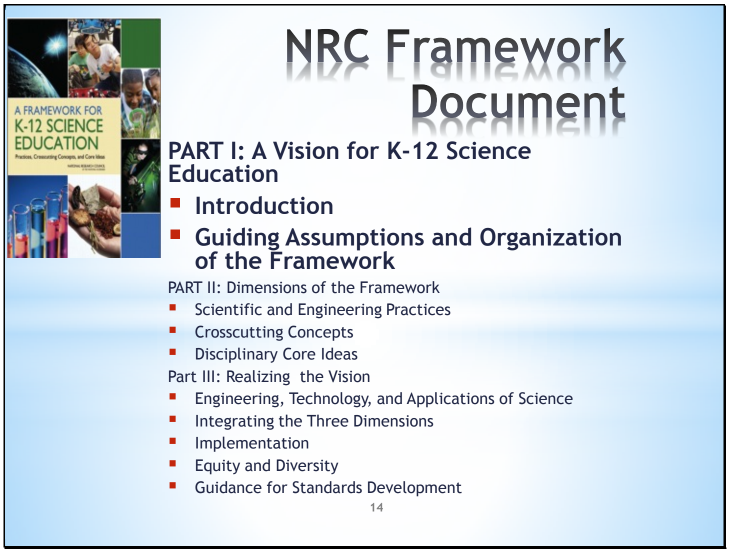
Slide 13



This is Part 3 of the document
This section includes an explanation of why the 3 dimensions must be taught together not separately like “Chapter 1- Nature of Science” has been taught in the past.
Also includes sections that discuss implementation, equity and diversity, and research. In addition, there is a section that provides guidance for standards developers.

The point is that the NRC *Frameworks*' vision is meant to be implemented over years, to learn from other states' implementation successes and failures, and to build upon the lessons learned in the Common Core State Standards (CCSS) implementation process.

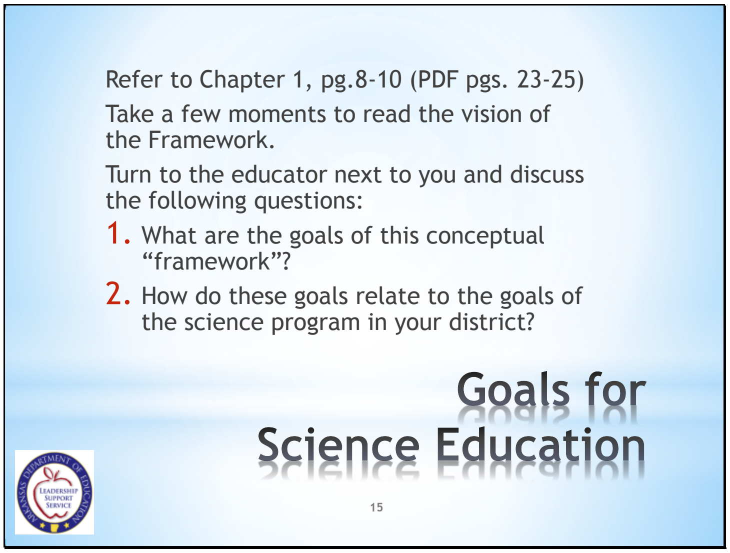
Slide 14



Point out:
This is the NRC (National Research Council) *Framework*. It is the foundational document upon which the NGSS were developed.

PART I is composed of Chapter 1: vision statement and Chapter 2: Guiding Assumptions and organization of the *Framework*

Slide 15



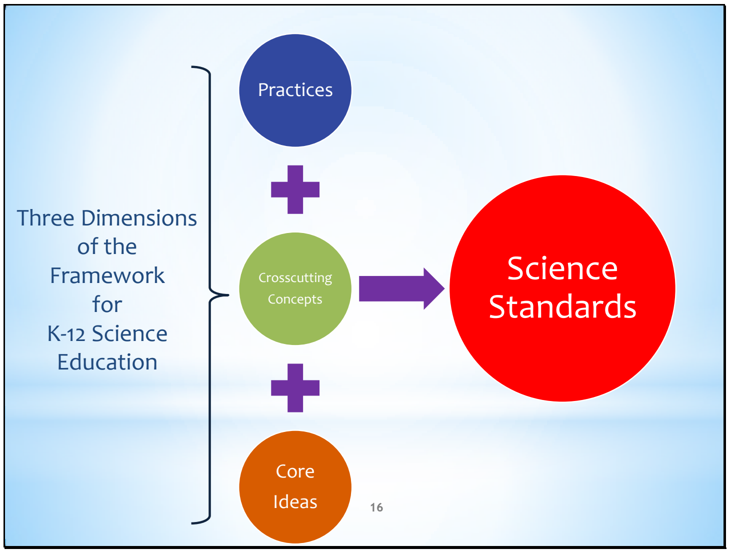
Turn to Chapter 1 Give them 5 minutes to read the vision on pg. 8-10 (PDF pgs. 23-25)
Stop reading on page 10 "Achieving the Vision"
Allow for a 5 minute discussion with 1 minute for each question.

Goals of the *Framework*
• Coherent Investigation of core ideas across multiple years of school
• More seamless blending of practices with core ideas and crosscutting concepts

Engage the teachers here in the process of "embracing the vision." This is both new and should be consisting with their existing understanding of science teaching and learning. It is important to remind how students learn science is by DOING science.

Also, Arkansas does not use the term "Frameworks" the same way as it is meant by the NRC *Framework*. AR uses the term to refer to its standards. NRC uses term to refer to a supporting document upon which standards are to be developed.

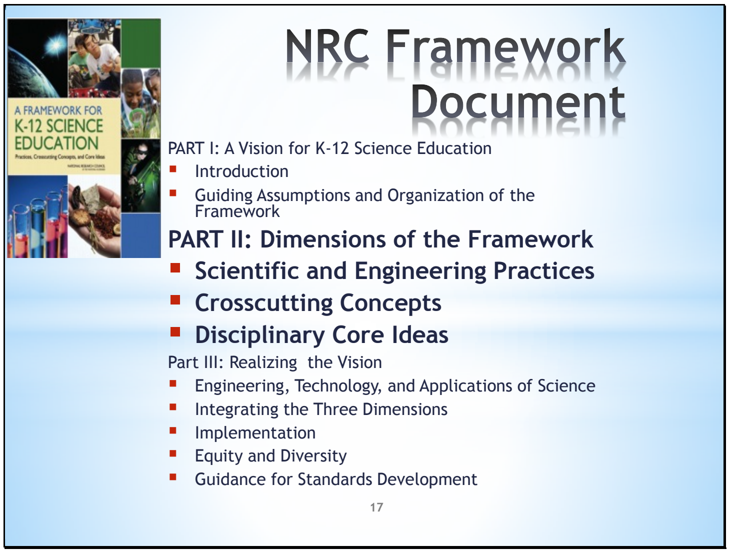
Slide 16



Turn to Chapter 2 pgs. 29-30 (PDF pgs. 44-45)
This chapter is about the structure of the *Framework*: 3 different dimensions that are taught in conjunction with each other:

- Focus is to be on the core ideas along with the practices.
- Science and engineering require knowledge and practice.
- Understanding develops over time.

Slide 17



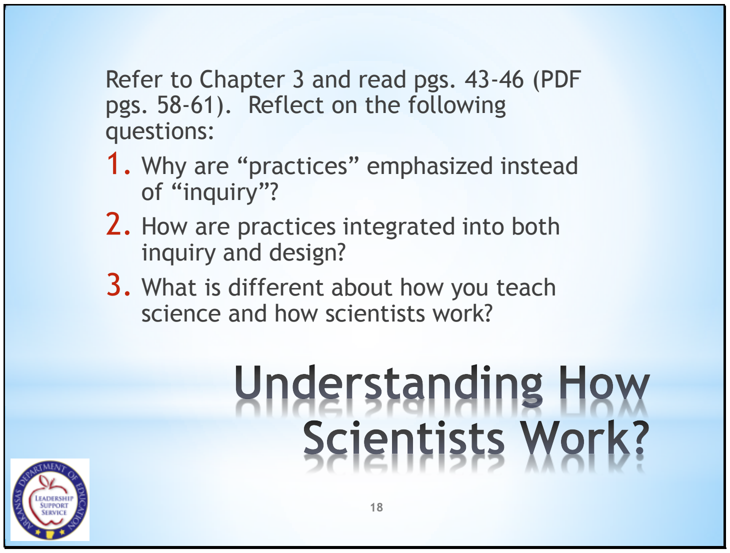
Sorting activity – sort components of the three dimensions (formative assessment).

Part 2 is the main focus for today. Understanding the 3 dimensions is key to understanding how science education is changing for the future with the goal to make ALL students college-and-career ready with 21st Century skills. STEM jobs are in demand now and will increase in demand in future years. We as educators need to prepare as many students as we can to fill those positions and to pursue science/engineering degrees in college.

Discussion of each practice/crosscutting concept/core idea is followed by a description of how students' knowledge and understanding progresses across K-12

Turn to page 33 (PDF pg. 48) & guide teachers to read about "progressions" across K-12

Slide 18



This section is about how scientists work. Give only 5 minutes or so here for teachers to read 3 pages.

Allow a minute or so to respond to each question

Answers:

1. Procedures are NOT so explicit. & inquiry is ambiguous and misinterpreted from the original science standards published in the 1990’s.

What distinguishes science from other ways of knowing is the reliance on evidence as central to science.

The use of practices is meant to:

- Minimize tendency to reduce scientific practice to a single set of procedures
- Avoids mistaken impression that there is 1 distinctive approach to science – a single “scientific method”
- Process of inquiry has been hampered by the lack of a commonly accepted of definition of inquiry

2. Refer teachers to Figure 3-1 pg. 45 (PDF pg. 60). They can read this section too.

3. We value and use science as a process of obtaining knowledge based on empirical evidence. “When such procedures are in isolation from science content, they become the aims of instruction in and of themselves rather than a means of developing a deeper understanding of the concepts and purposes of science”

Students and teachers need to understand how different this NEW Methodology is.

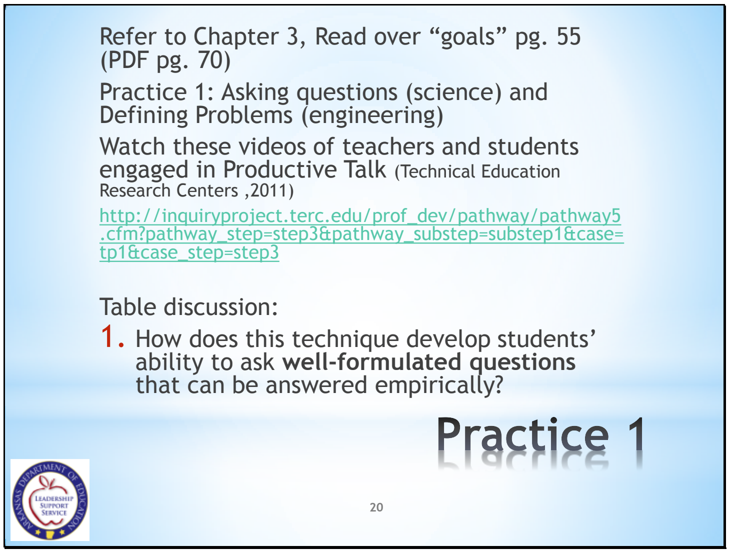
Slide 19

Maybe this a good time for a break.
When return from break, Group participants into groups of 4
Each person selects 2 practices to read and become an expert. Teach the others when all have read the pages.
Refer to Chapter 3. Turn to pgs. 49-82 (PDF Pgs. 64-97)
Framework describes each in detail and includes culminating 12th grade learning goals and what is known about learning progressions through grade levels.

Facilitator: Read each practice aloud. See BOX 3-2, pgs. 50-53 (PDF pgs. 65-69)
This perspective is an improvement over previous approaches, in several ways.

Practices in isolation from the content provides little meaning to these practices.
Note this section has a pattern: the practice is described, 12th grade goals are detailed, and an explanation of K-12 progression of how students develop these skills over time.

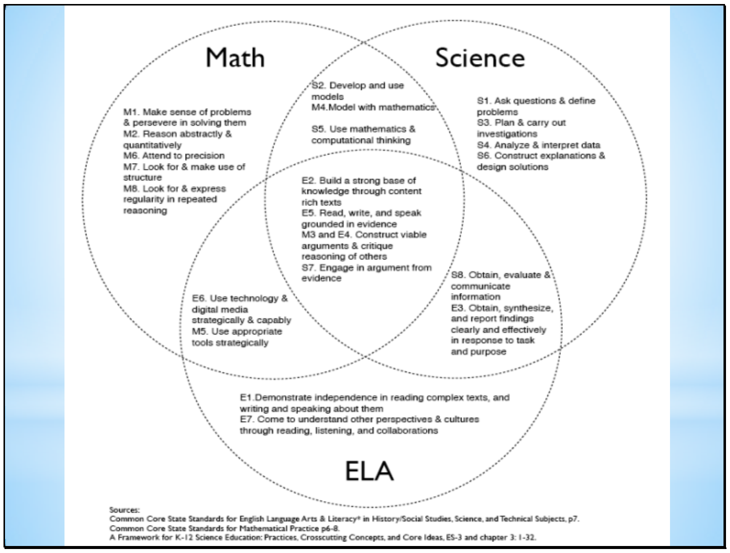
Slide 20



Videos from the Inquiry Project on Talk Science or also called Productive Talk

Read over “goals” of the 1st practice: asking questions. pg.55 (PDF pg. 69)
Notice this practice is both science and engineering.

Slide 21



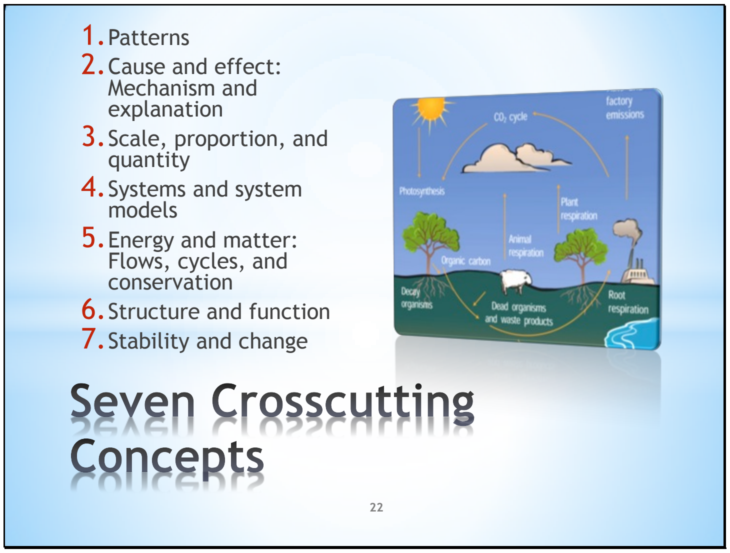
The complete document, CCSS and NRC Framework Venn Diagram, is found at
http://arkansasNGSS**.pbworks.com**

Direct teachers to BOX 3-1 pg. 42 (PDF pg. 57).
Make the point that there are NO Common Core Science Standards. The CCSS for English/Language Arts includes science reading/writing standards. The new science content standards are called *Next Generation Science Standards.*

Facilitate teachers' understanding of how the ELA Capacities, Math Practices, and Science/Engineering Practices are similar. Make the point that these practices/capacities are not an additional thing teachers need to learn and do. There is a lot of overlap! Research shows that students who are engaged in sustained practices in any of these 3 domains improve achievement scores across ALL domains. Each set of Practices /capacities support and improve student understanding/knowledge in ALL three of these domains.

H.O. – Venn diagram – Relationships and Convergences Found between the CCSS for Mathematics and Literacy and the practices from *A Framework for K-12 Science Education.*

Slide 22

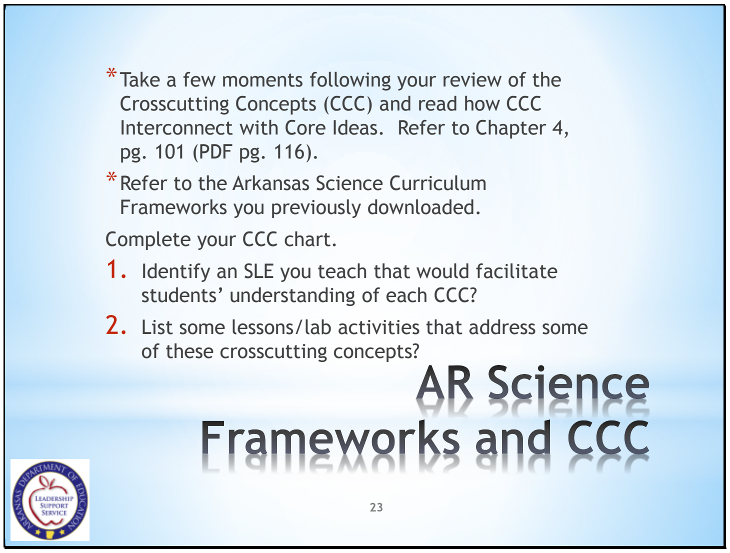


Suggest dismissing for LUNCH
After lunch Refer to Chapter 4 pg. 83 (PDF pg. 98) – H.O. Crosscutting concepts (CCC) Table
The first CCC is patterns. Here (image) is a collection of plant specimens the exhibit similar patterns. One major use of patterns is in classification. The *Framework* acknowledges that classification depends on careful observation of similarities and differences. Objects in nature can be classified into groups on careful observation of similarities of visible features, microscopic features, or on the basis of function.

H.O. – Crosscutting concepts table **http://arkansasNGSS.pbworks.com** (Complete the first two columns: Give teachers 30 minutes to read and complete the first 2 columns)

Facilitator jigsaws across the room numbering participants 1-7. All 1's study CCC #1; all 2's study CCC #2 and so on. This will take several minutes because each concept is many pages. Participants use the chart and fill out what they learn for each CCC. They use it to teach the others.
This section also has a pattern: each CCC is described and then followed by the K-12 progression of the concept.
CCC is the 2nd dimension of the *Framework*. Crosscutting concepts are fundamental to an understanding of science and engineering in ALL domains of science.

Slide 23

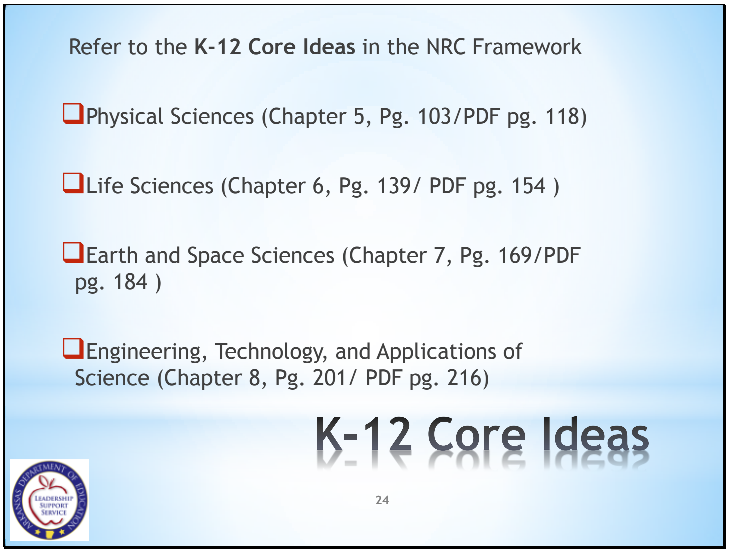


H.O.: Crosscutting concepts Table: complete last two columns
This should take another 30 minutes

Direct Teachers to the ADE web site and view the AR Curriculum Science Standards
http://www.arkansased.org/divisions/learning-services/curriculum-and-instruction/frameworks/curriculum_categories/science

Point out that CCC's is fundamental to an understanding of Science, yet students are often expected to develop knowledge without any explicit instructional support.
Research indicates:
1. CCC are interwoven with the other dimensions.
2. Students should understand CCC's are integral across disciplines and grade-levels.
3. Development of CCC's in multiple disciplinary contexts can help students develop an understanding of science and engineering through K-12.

Slide 24

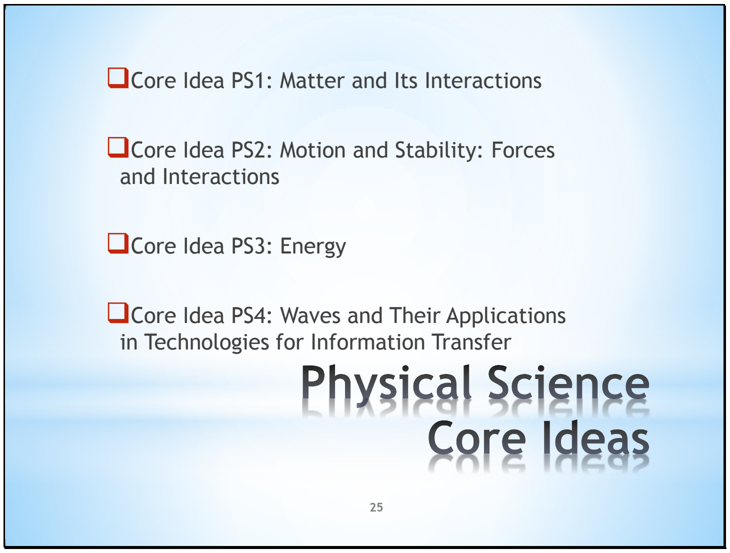


Students are to be taught less science facts. Teachers are to guide students deeper into these 4 core ideas to insure students truly UNDERSTAND the core ideas set forth in these documents.
Give participants several minutes or so to look over each Core Idea. Give teachers 15 minutes to do so then DISMISS FOR 15 MINUTE BREAK.

These Chapters have a similar pattern to the others:
Each core idea is introduced with information on the science domain, then 1, 2, 3 and/or 4 core ideas are presented that include an essential question designed to show some aspect of the world the idea helps to explain.
Each core idea is broken down into sub-core ideas that also are accompanied with essential questions (EQ) and grade-band endpoints.
Each core idea chapter is concluded with a list of supporting references.
Grand-band end points are indicators of what students should know and be able to do at the ends of grade 2, grade 5, grade 8, and grade 12.

Framework emphasizes developing students' proficiency in science across grades K-12 following the logic of learning progressions (not the charge of the *Framework* committee to develop detailed learning progressions but guides are provided)

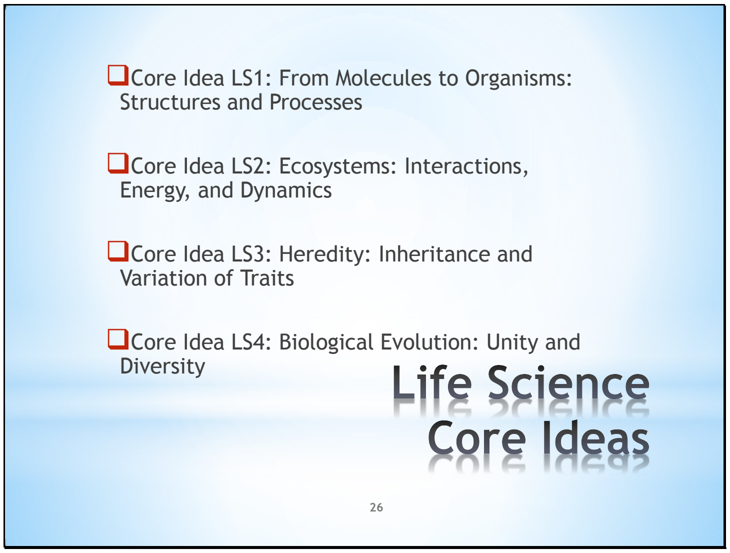
Slide 25



Suggest 15 minute BREAK
Discuss how content will change. Remind them again and again these core ideas are NOT meant to dictate courses. Bring their attention to the grade-band endpoints on each of the four Core idea slides. Set of grade-band endpoints, (grade 2, 5, 8, and 12) were informed by research on teaching and learning and describe the developing understanding that students should have acquired by these endpoints.

Refer teachers to the BOX 5-1 on pg. 105 (PDF pg. 120). Bring to their attention to how these core ideas and sub-core ideas are numbered and lettered.
BOX 5-1
Core and Component Ideas in the Physical Sciences
PS1: Matter and Its Interactions
PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions
PS1.C: Nuclear Processes
PS2: Motion and Stability: Forces and Interactions
PS2.A: Forces and Motion
PS2.B: Types of Interactions
PS2.C: Stability and Instability in Physical Systems
PS3: Energy
PS3.A: Definitions of Energy
PS3.B: Conservation of Energy and Energy Transfer
PS3.C: Relationship between Energy and Forces
PS3.D: Energy in Chemical Processes and Everyday Life
PS4: Waves and Their Applications in Technologies for Information Transfer
PS4.A: Wave Properties
PS4.B: Electromagnetic Radiation
PS4.C: Information Technologies and Instrumentation.

Slide 26



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Bring to their attention to how these core ideas and sub-core ideas are numbered and lettered.
BOX 6-1 pg. 142 (PDF pg. 157)
Core and Component Ideas in the Life Sciences
LS1: From Molecules to Organisms: Structures and Processes
LS1.A: Structure and Function
LS1.B: Growth and Development of Organisms
LS1.C: Organization for Matter and Energy Flow in Organisms
LS1.D: Information Processing
LS2: Ecosystems: Interactions, Energy, and Dynamics
LS2.A: Interdependent Relationships in Ecosystems
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
LS2.C: Ecosystems Dynamics, Functioning, and Resilience
LS2.D: Social Interactions and Group Behavior
LS3: Heredity: Inheritance and Variation of Traits
LS3.A: Inheritance of Traits
LS3.B: Variation of Traits
LS4: Biological Evolution: Unity and Diversity
LS4.A: Evidence of Common Ancestry and Diversity
LS4.B: Natural Selection
LS4.C: Adaptation
LS4.D: Biodiversity and Humans

Slide 27

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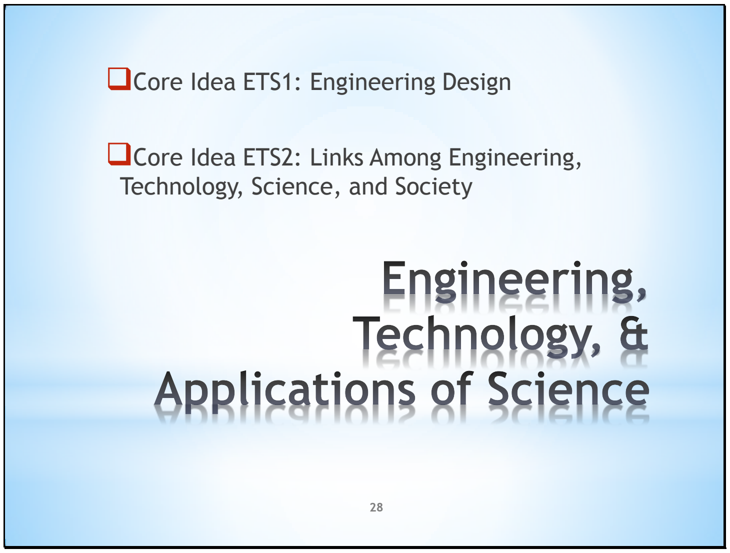
Bring to their attention to how these core ideas and sub-core ideas are numbered and lettered.
BOX 7-1 pg. 171 (PDF pg. 186)
Core and Component Ideas in Earth and Space Sciences
ESS1: Earth's Place in the Universe
ESS1.A: The Universe and Its Stars
ESS1.B: Earth and the Solar System
ESS1.C: The History of Planet Earth
ESS2: Earth's Systems
ESS2.A: Earth Materials and Systems
ESS2.B: Plate Tectonics and Large-Scale System Interactions
ESS2.C: The Roles of Water in Earth's Surface Processes
ESS2.D: Weather and Climate
ESS2.E: Biogeology
ESS3: Earth and Human Activity
ESS3.A: Natural Resources
ESS3.B: Natural Hazards
ESS3.C: Human Impacts on Earth Systems
ESS3.D: Global Climate Change

Slide 28



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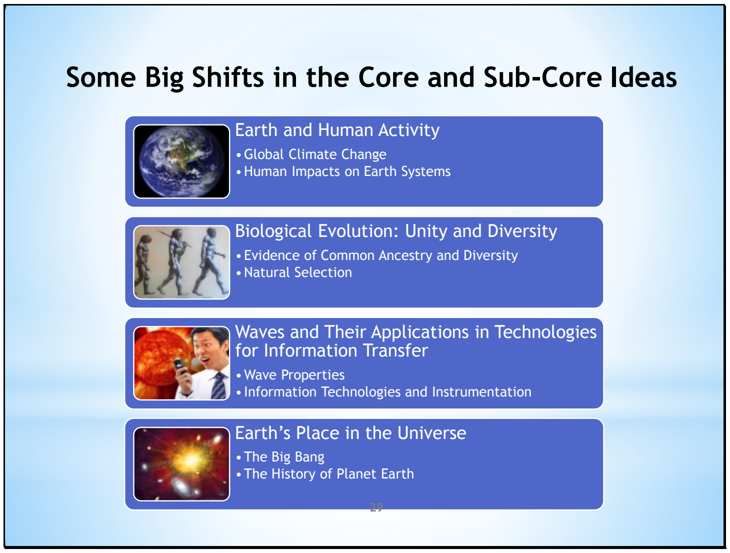
Bring to their attention to how these core ideas and sub-core ideas are numbered and lettered. This core idea is a BIG SHIFT in 21st Century science education. This will be a critical piece for curriculum developers and pre-service teacher instruction.

BOX 8-1 pg. 202 (PDF pg. 217)
Definitions of Technology, Engineering, and Applications of Science
Technology is any modification of the natural world made to fulfill human needs or desires [2].
Engineering is a systematic and often iterative approach to designing objects, processes, and systems to meet human needs and wants [2].
An application of science is any use of scientific knowledge for a specific purpose, whether to do more science; to design a product, process, or medical treatment; to develop a new technology; or to predict the impacts of human actions.

BOX 8-2 pg. 203 (PDF pg. 218)
Core and Component Ideas in Engineering, Technology, and Applications of Science
ETS1: Engineering Design
ETS1.A: Defining and Delimiting an Engineering Problem
ETS1.B: Developing Possible Solutions
ETS1.C: Optimizing the Design Solution
ETS2: Links among Engineering, Technology, Science, and Society
ETS2.A: Interdependence of Science, Engineering, and Technology
ETS2.B: Influence of Engineering, Technology and Science on Society and the Natural World

Slide 29



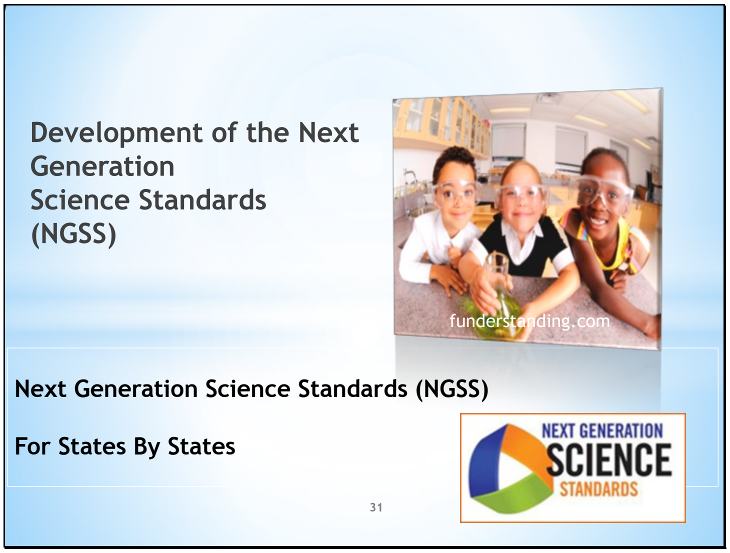
Make the point that this content is based on current vetted SCIENCE RESEARCH that is widely accepted and peer reviewed.
Framework's Rigor of content will be mirrored in the Standards
This content is the FLOOR not the CEILING of what students should know and be able to do.

- Climate change is impacted by human activity.
- Biological evolution is based on evidence of common ancestry and diversity.
- New content on wave technology was NOT included in the original national standards. This is real world application for students (cell phone technology and the impacts of solar flares on human activity).
- Big Bang Theory is based on the age of the universe and rocks on Earth in billions of years.

Slide 30

Bring participant's attention to Part 3 of the document, Realizing the Vision. As we move into a discussion of NGSS these topics will become clearer.

Slide 31



The NRC *Framework* is from the scientific community. Its principles focus on how students learn science, core scientific ideas accepted by the scientific community, the development of understanding over time, the connection between knowledge and Practice , student interest and experiences, and the promotion of equity.

The science content of *Next Gen. Science Standards* is taken directly from the *Framework*. NGSS development process is now at the public comment phase. First public release was at the end of April 2012. Look for another opportunity to comment on these standards in the fall of 2012.

Slide 32

Picture is a hyperlink to the video on the NGSS website.

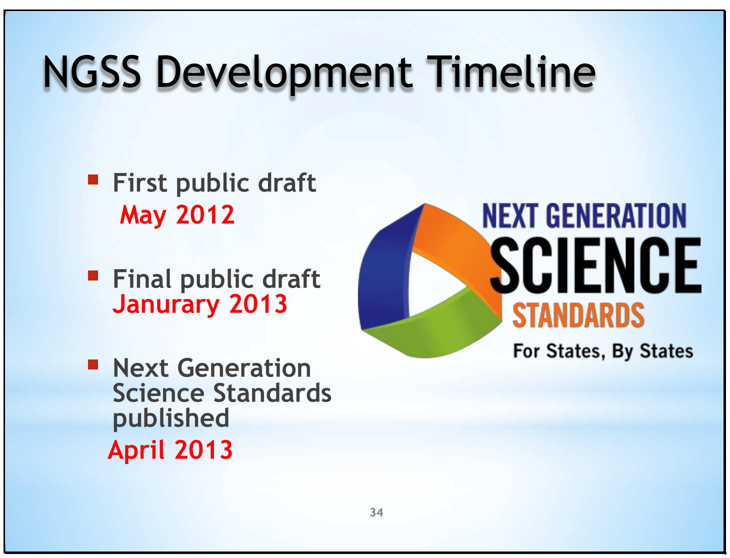
These colors mean something!!
Content IS integrated with the crosscutting concepts and science and engineering practice to develop the standards.
The core disciplinary ideas are from which the NGSS content is based and are being re-written into student learning expectations.
Science and engineering practices such as posing questions, designing investigations, developing scientific explanations, and constructing and/or using models are meant to help students understand and research scientific principles.
Crosscutting concepts such as systems, form and function, and cause and effect are meant to help students to make connections between the various branches of science.

The final standards will give teachers, curriculum and assessment developers, and administrators guidance in how to blend practices, crosscutting concepts and content to full and more seamless integration.

Slide 33

For Today's Students and Tomorrow's Workforce:
NGSS is the floor NOT the Ceiling of what should be taught to ALL students.

Slide 34



The NGSS was developed collaboratively with states and other stakeholders in science, science education, higher education and industry. Additional review and guidance was provided by advisory committees composed of nationally-recognized leaders in science (NSTA) and science education as well as business and industry.

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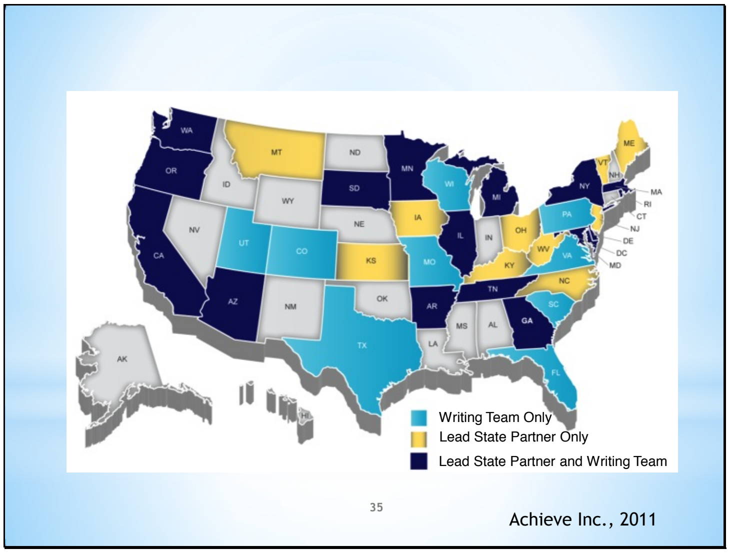

HOW is ARKANSAS INVOLVED?
AR is one of 26 lead state partners composed of a:
Broad Geographic Representation that Account for 58% of the nation’s public school students
__Stephen Pruitt (vice president of Achieve Inc. who has been commissioned to write the NGSS): Through our various writing teams and stakeholder groups we have representation from every state in the nation as well as from Puerto Rico, from a diverse community of elementary, middle, and high school teachers (from both rural and urban communities), administrators, state science directors and other key curriculum and assessment developers at the state level, as well as experts in career tech and the scientific fields of cognition, life science, earth science, physical science, and engineering.
____
Arkansas has two members on the writing team
The writing team is truly led by the education community– most specifically K-12 educators and administrators that are in the classroom every day. The utility of the document is paramount and if the resulting standards aren’t useful in application, we would consider them a failed initiative. Members of the writing team represent elementary, middle, and high school educators in both urban and rural communities. This prestigious group includes State Teachers of the Year, Einstein Fellows, and Presidential Award for Excellence in Mathematics and Science Teaching winners and individuals who hold offices in their respective professional organizations.____
Arkansas has a review team of 29 members from across the state representing CTE, ASTA, STEM Centers, Service cooperatives, K-12 science, literacy and math teachers, Business leaders, Higher education professionals, ADE assessment, curriculum & professional development representatives.

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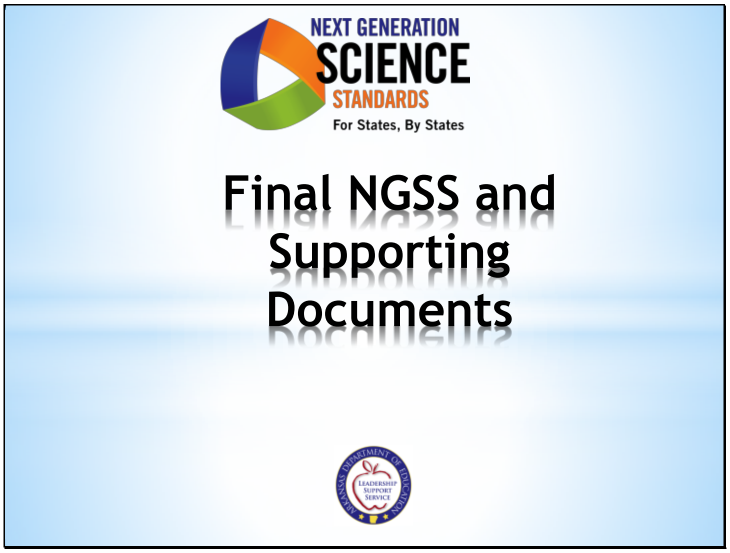

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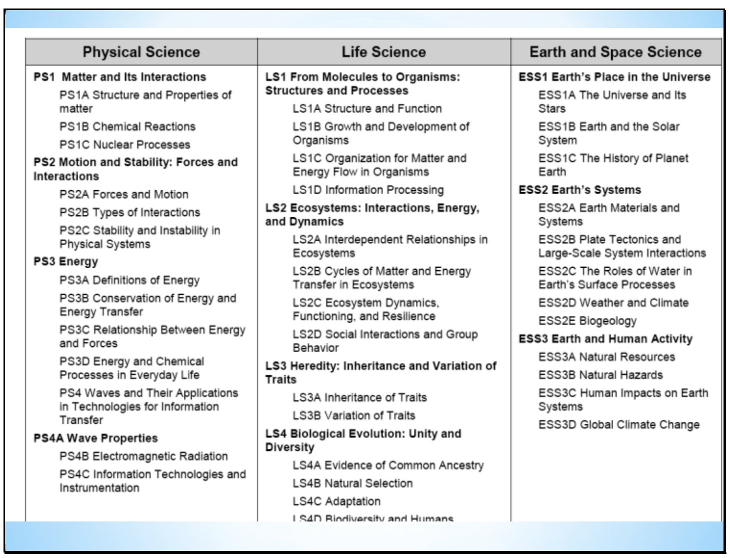

Physical Science	Life Science	Earth and Space Science
PS1 Matter and Its Interactions PS1A Structure and Properties of matter PS1B Chemical Reactions PS1C Nuclear Processes **PS2 Motion and Stability: Forces and Interactions** PS2A Forces and Motion PS2B Types of Interactions PS2C Stability and Instability in Physical Systems **PS3 Energy** PS3A Definitions of Energy PS3B Conservation of Energy and Energy Transfer PS3C Relationship Between Energy and Forces PS3D Energy and Chemical Processes in Everyday Life PS4 Waves and Their Applications in Technologies for Information Transfer **PS4A Wave Properties** PS4B Electromagnetic Radiation PS4C Information Technologies and Instrumentation	**LS1 From Molecules to Organisms: Structures and Processes** LS1A Structure and Function LS1B Growth and Development of Organisms LS1C Organization for Matter and Energy Flow in Organisms LS1D Information Processing **LS2 Ecosystems: Interactions, Energy, and Dynamics** LS2A Interdependent Relationships in Ecosystems LS2B Cycles of Matter and Energy Transfer in Ecosystems LS2C Ecosystem Dynamics, Functioning, and Resilience LS2D Social Interactions and Group Behavior **LS3 Heredity: Inheritance and Variation of Traits** LS3A Inheritance of Traits LS3B Variation of Traits **LS4 Biological Evolution: Unity and Diversity** LS4A Evidence of Common Ancestry LS4B Natural Selection LS4C Adaptation LS4D Biodiversity and Humans	**ESS1 Earth's Place in the Universe** ESS1A The Universe and Its Stars ESS1B Earth and the Solar System ESS1C The History of Planet Earth **ESS2 Earth's Systems** ESS2A Earth Materials and Systems ESS2B Plate Tectonics and Large-Scale System Interactions ESS2C The Roles of Water in Earth's Surface Processes ESS2D Weather and Climate ESS2E Biogeology **ESS3 Earth and Human Activity** ESS3A Natural Resources ESS3B Natural Hazards ESS3C Human Impacts on Earth Systems ESS3D Global Climate Change

NGSS Structure (see doc on NGSS Website)

The codes for the performance expectations were derived from the *Framework*. As with the titles, the first digit indicates a grade K-5, or specifies MS (middle school) or HS (high school). The next alpha-numeric code specifies the discipline, core idea and sub-idea. All of these codes are shown in the table below, derived from the *Framework*. Finally, the number at the end of each code indicates the order in which that statement appeared as a DCI in the *Framework.*

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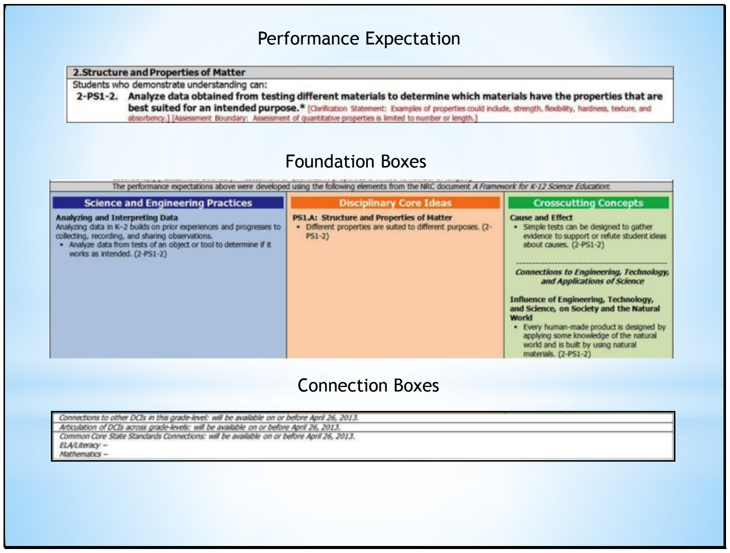

Send some time with group reviewing the document - How to Read the *Next Generation Science Standards (*NGSS*)*

All three of these components make up a standard
PE
Foundation boxes
Connection boxes

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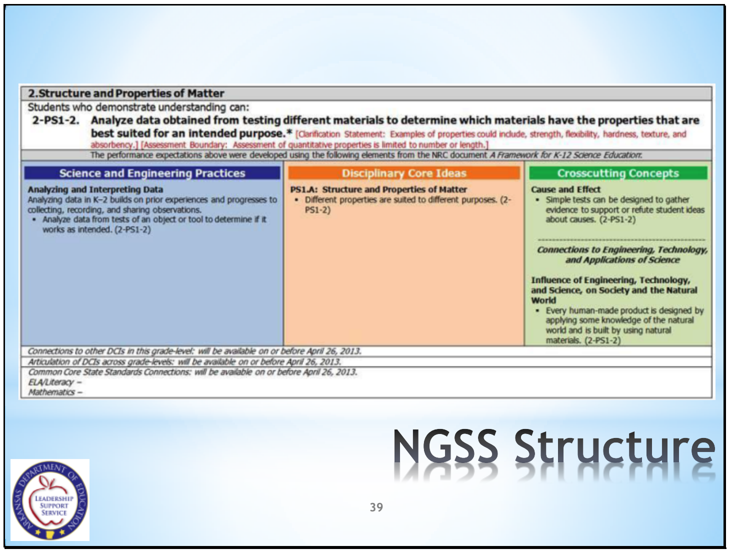
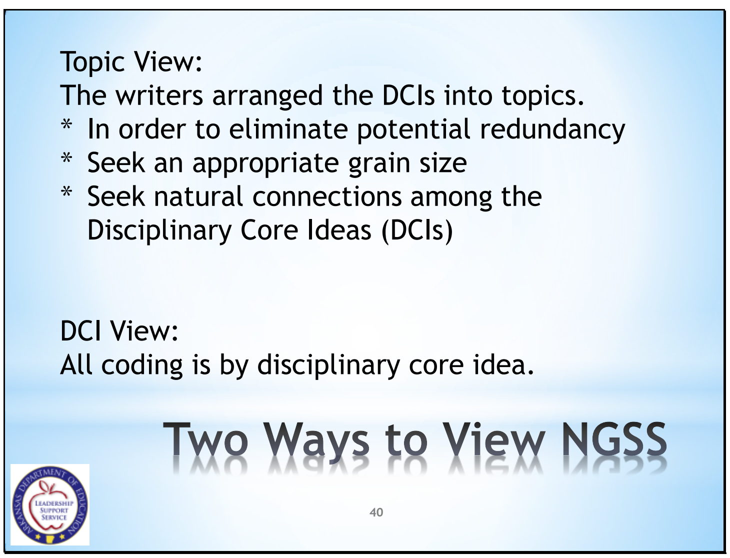


This is a picture of a standard which includes a performance expectation .

Slide 40



Due to the fact that the NGSS progress toward end-of-high school core ideas, the standards may be rearranged in any order within a grade level.
Interactive versions of the standards will be available soon.
This structure provided the original basis of the standards, and is preferred by many states. However, the coding structure of individual performance expectations reflects the DCI arrangement in the *Framework.*

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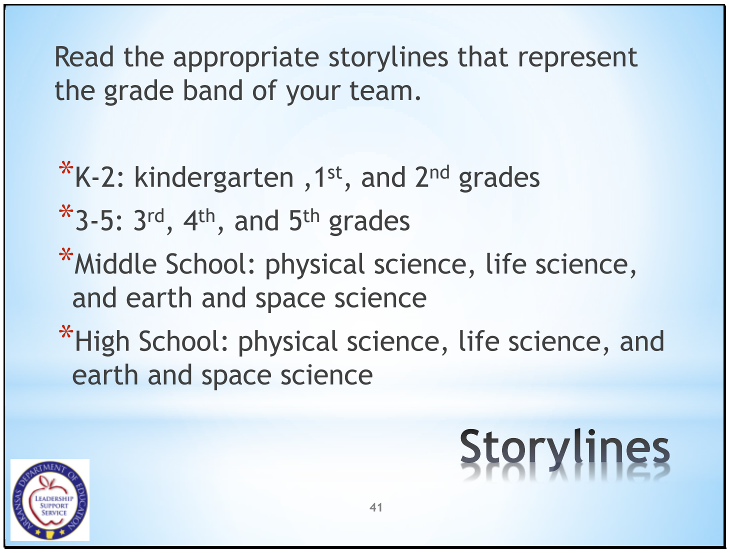

As a presenter decide which view, DCI or Topic to use with this presentation. Suggest grouping participants in grade bands. For a quick overview, as teams, read the storylines in their grade band and share out.

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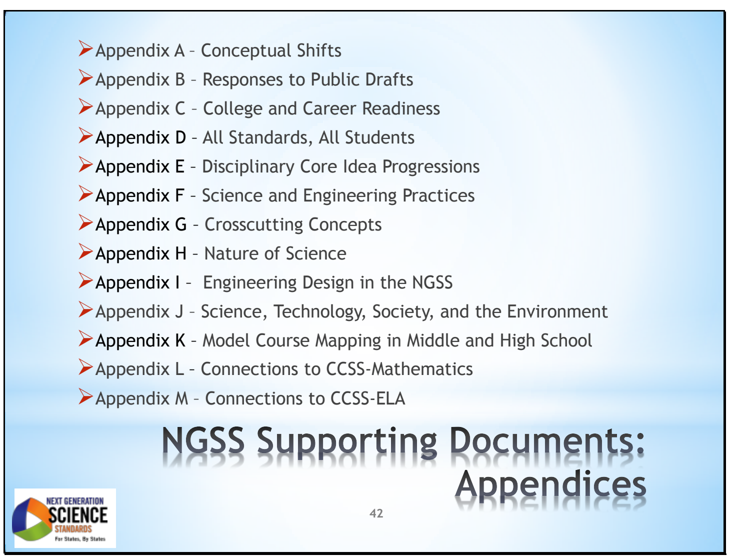

It is up to your discretion as to how long you spend in these appendices during your session, but it highly recommended that time be devoted to make educators aware.

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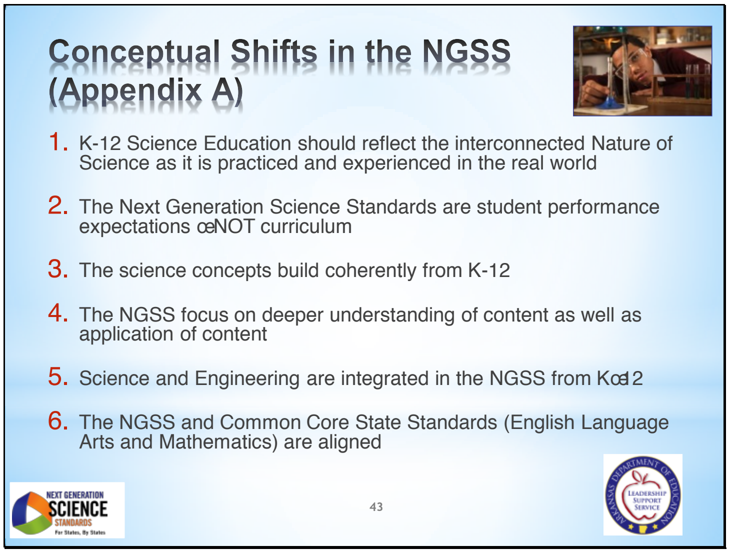

- *"…learning about science and engineering involves integration of the knowledge of scientific explanations (i.e., content knowledge) and the practices needed to engage in scientific inquiry and engineering design. Thus the framework seeks to illustrate how knowledge and practice must be intertwined in designing learning experiences in K–12 science education." (NRC 2011)*
- Even though within each performance expectation, science and engineering practices are partnered with a particular disciplinary core idea and crosscutting concept in the NGSS, these intersections do not predetermine how the three are linked in the curriculum, units, or lessons; they simply clarifies the expectations of what students will know and be able to do be the end of the grade or grade band. Additional work will be needed to create coherent instructional programs that help students achieve these standards. It is essential to understand that the emphasis placed on a particular science and engineering practice or crosscutting concept in a performance expectation is not intended to limit instruction, but to make clear the intent of the assessments.
- First, focus and coherence must be a priority. Second, the progressions in the NGSS automatically assume that previous material has been learned by the student.
- It is important that teachers and curriculum/assessment developers understand that the focus is on the core ideas —not necessarily the facts that are associated with them. The facts and details are important evidence, but not the sole focus of instruction. –Enhanced rigor and cognitive demand.
- By integrating technology and engineering into the science curriculum teachers can empower their students to use what they learn in their everyday lives.
- There is an opportunity for science to be part of a child's comprehensive education.

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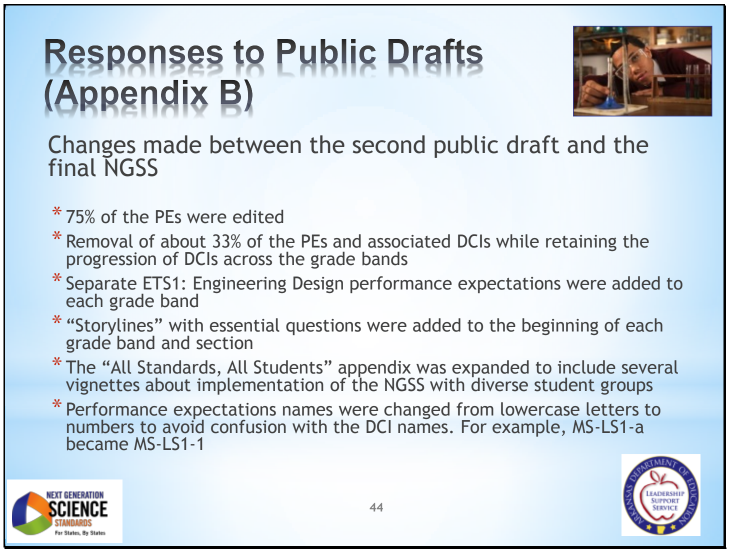

- Referring to previous drafts will not be productive
- See Appendix C
- Based on feedback
- PEs aligned to engineering are designated with an asterisk. Appendix I - explicit inclusion of engineering and technology opens the door to curriculum materials that communicate to students the broad spectrum of career opportunities that includes not only scientists but also technicians, engineers, and other careers that require knowledge and abilities in the STEM fields. There was a commitment to fully integrate engineering design, technology, and mathematics into the structure of science education by raising engineering design to the same level as scientific inquiry when teaching science disciplines at all levels, from kindergarten to grade 12
- Appendix K – As a result of May draft additional quantitative expectations were added particularly in the physical sciences

6. Nature of Science (NOS)
    - learning about the nature of science requires more than engaging in activities and conducting investigations
    - Appendix H – has more information, a matrix of eight NOS categories and good examples of how teachers can use practices and CCCs to emphasis the nature of science
    - It is important to note that while the Nature of Science was reflected in the Framework through the practices, understanding the Nature of Science is more than just practice.
7. See Appendix F for SEP matrix

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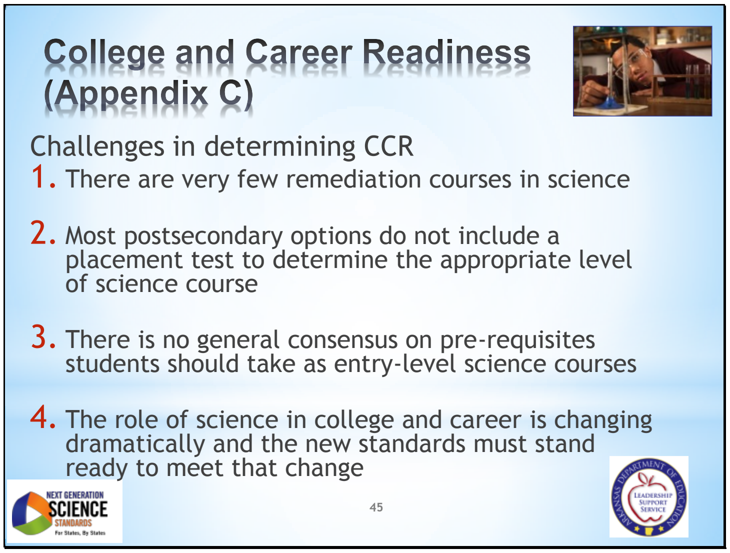

- There are very few remediation courses in science.
- Most postsecondary options do not include a placement test to determine the appropriate level of science course.
- There is no general consensus on pre-requisites students should take as entry-level science courses.
- The role of science in college and career is changing dramatically and the new standards must stand ready to meet that change.

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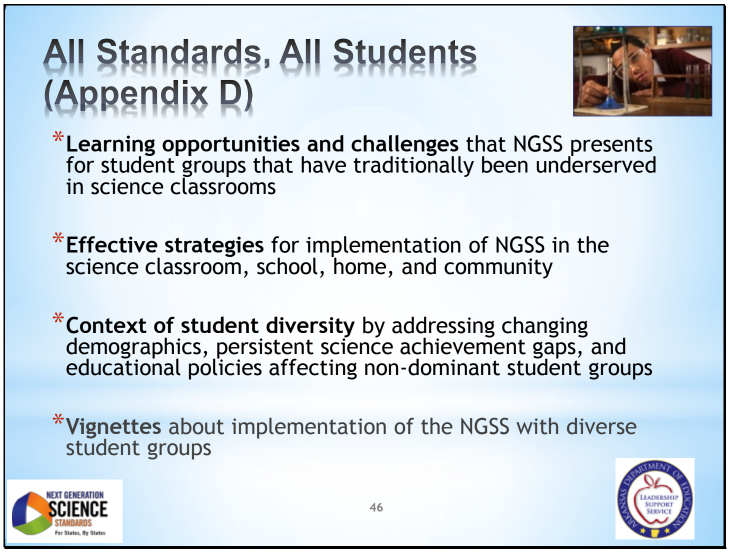

Learning opportunities

- NGSS, by emphasizing engineering, recognizes contributions of other cultures historically.
- Engineering has potential to be inclusive of students who have traditionally been marginalized in the science classroom and do not see relevance of science or engineering to their lives or future.
- Focus on Practices require reading, writing, speaking- allow for opportunities for language acquisition
- Connection to CCSS ELA

Effective strategies

- Overview of the research on effective strategies by sub-populations (non-dominant groups)
- Info on involving parents and community members in science
- Solving community-based problems

Context

- Provides stats on changing demographics for sub-pops
- One factor that I felt was overlooked was isolated, rural populations with limited access to outside cultures and resources
- Student achievement measures – assessment
  - Made the point that standardized tests do not analyze or report interactions between variables – e.g. – minorities are disproportionally represented in free and reduced lunch stats
  - Added attention to standardized testing does not necessarily result in higher student achievement
- Conclusion – Science teachers need effective strategies to include all students

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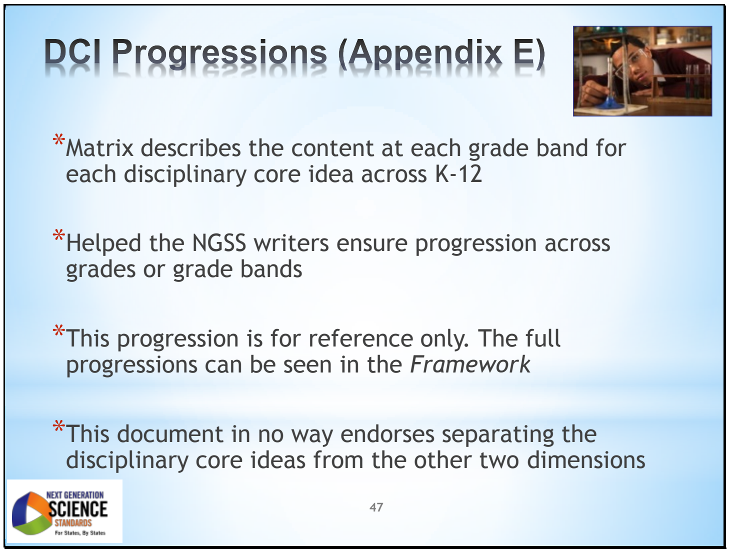

They describe the content that occurs at each grade band. Some of the sub-ideas within the disciplinary core ideas overlap significantly.

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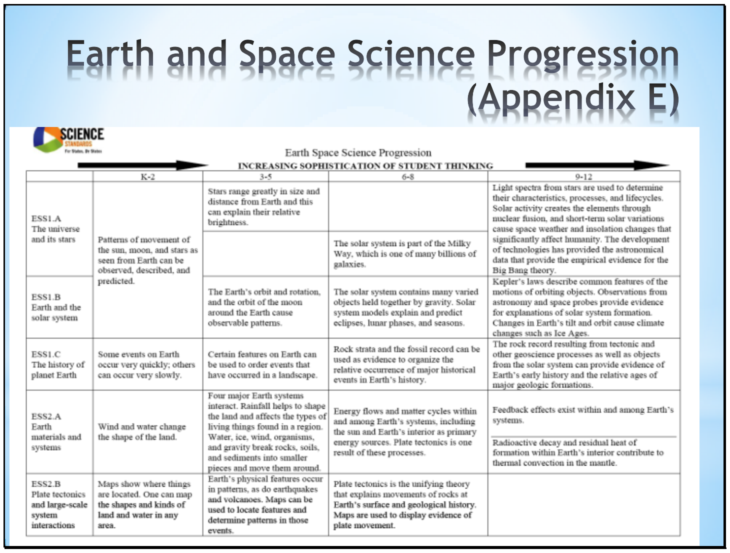

	K-2	3-5	6-8	9-12
ESS1.A The universe and its stars	Patterns of movement of the sun, moon, and stars as seen from Earth can be observed, described, and predicted.	Stars range greatly in size and distance from Earth and this can explain their relative brightness.	The solar system is part of the Milky Way, which is one of many billions of galaxies.	Light spectra from stars are used to determine their characteristics, processes, and lifecycles. Solar activity creates the elements through nuclear fusion, and short-term solar variations cause space weather and insolation changes that significantly affect humanity. The development of technologies has provided the astronomical data that provide the empirical evidence for the Big Bang theory.
ESS1.B Earth and the solar system		The Earth's orbit and rotation, and the orbit of the moon around the Earth cause observable patterns.	The solar system contains many varied objects held together by gravity. Solar system models explain and predict eclipses, lunar phases, and seasons.	Kepler's laws describe common features of the motions of orbiting objects. Observations from astronomy and space probes provide evidence for explanations of solar system formation. Changes in Earth's tilt and orbit cause climate changes such as Ice Ages.
ESS1.C The history of planet Earth	Some events on Earth occur very quickly; others can occur very slowly.	Certain features on Earth can be used to order events that have occurred in a landscape.	Rock strata and the fossil record can be used as evidence to organize the relative occurrence of major historical events in Earth's history.	The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth's early history and the relative ages of major geologic formations.
ESS2.A Earth materials and systems	Wind and water change the shape of the land.	Four major Earth systems interact. Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, organisms, and gravity break rocks, soils, and sediments into smaller pieces and move them around.	Energy flows and matter cycles within and among Earth's systems, including the sun and Earth's interior as primary energy sources. Plate tectonics is one result of these processes.	Feedback effects exist within and among Earth's systems. Radioactive decay and residual heat of formation within Earth's interior contribute to thermal convection in the mantle.
ESS2.B Plate tectonics and large-scale system interactions	Maps show where things are located. One can map the shapes and kinds of land and water in any area.	Earth's physical features occur in patterns, as do earthquakes and volcanoes. Maps can be used to locate features and determine patterns in those events.	Plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history. Maps are used to display evidence of plate movement.	

"First, it is built on the notion of learning as a developmental progression

Second, the framework focuses on a limited number of core ideas in science and engineering both within and across the disciplines.

Third, the framework emphasizes that learning about science and engineering involves integration of the knowledge of scientific explanations (i.e., content knowledge) and the practices needed to engage in scientific inquiry and engineering design. Thus the framework seeks to illustrate how knowledge and practice must be intertwined in designing learning experiences in K-12 science education." - NRC *Framework for K-12 Science Education*, 1-3

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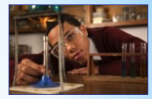
Science and Engineering Practices (Appendix F)



Guiding Principles

* Students in grades K-12 should engage in all of the eight practices over each grade band
* Practices grow in complexity and sophistication across the grades
* Each practice may reflect science or engineering
* Practices represent what students are expected to do, and are not teaching methods or curriculum
* The eight practices are not separate; they intentionally overlap and interconnect
* Performance expectations focus on some but not all capabilities associated with a practice

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Appendix F has a progression matrix for each Practice .

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Practices Matrix: Asking Questions

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Asking Questions and Defining Problems A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.	Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.	Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.	Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, clarify arguments and models.	Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
	• Ask questions based on observations to find more information about the natural and/or designed world(s).	• Ask questions about what would happen if a variable is changed.	• Ask questions ◦ that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. ◦ to identify and/or clarify evidence and/or the premise(s) of an argument. ◦ to determine relationships between independent and dependent variables and relationships in models.. ◦ to clarify and/or refine a model, an explanation, or an engineering problem.	• Ask questions ◦ that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. ◦ that arise from examining models or a theory, to clarify and/or seek additional information and relationships. ◦ to determine relationships, including quantitative relationships, between independent and dependent variables. ◦ to clarify and refine a model, an explanation, or an engineering problem.
	• Ask and/or identify questions that can be answered by an investigation.	• Identify scientific (testable) and non-scientific (non-testable) questions. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	• Ask questions that require sufficient and appropriate empirical evidence to answer. • Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	• Evaluate a question to determine if it is testable and relevant. • Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
			• Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.	• Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of

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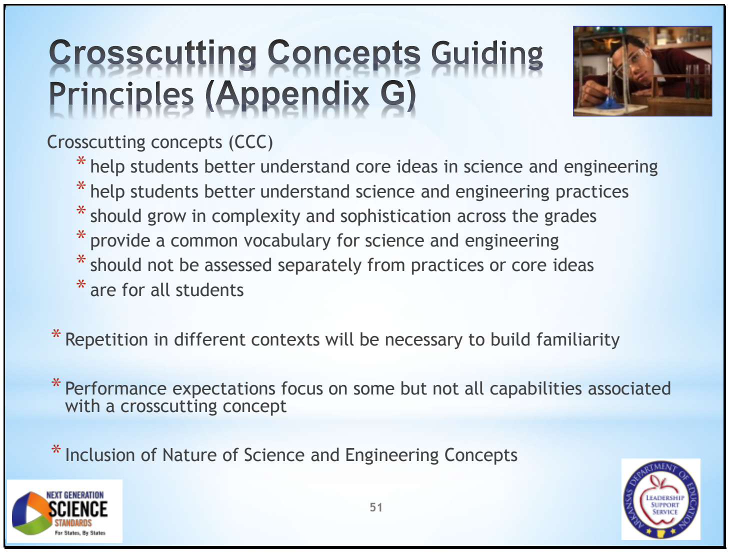

Framework does not specify grade-band endpoints for the crosscutting concepts, but instead provides a summary of what students should know by the end of grade twelve and a hypothetical progression for each.

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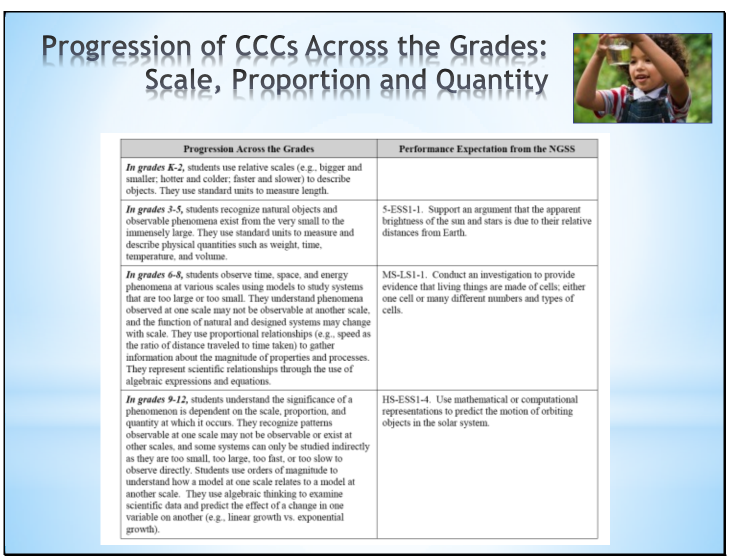

Progression Across the Grades	Performance Expectation from the NGSS
In grades K-2, students use relative scales (e.g., bigger and smaller; hotter and colder; faster and slower) to describe objects. They use standard units to measure length.	
In grades 3-5, students recognize natural objects and observable phenomena exist from the very small to the immensely large. They use standard units to measure and describe physical quantities such as weight, time, temperature, and volume.	5-ESS1-1. Support an argument that the apparent brightness of the sun and stars is due to their relative distances from Earth.
In grades 6-8, students observe time, space, and energy phenomena at various scales using models to study systems that are too large or too small. They understand phenomena observed at one scale may not be observable at another scale, and the function of natural and designed systems may change with scale. They use proportional relationships (e.g., speed as the ratio of distance traveled to time taken) to gather information about the magnitude of properties and processes. They represent scientific relationships through the use of algebraic expressions and equations.	MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
In grades 9-12, students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Students use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).	HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

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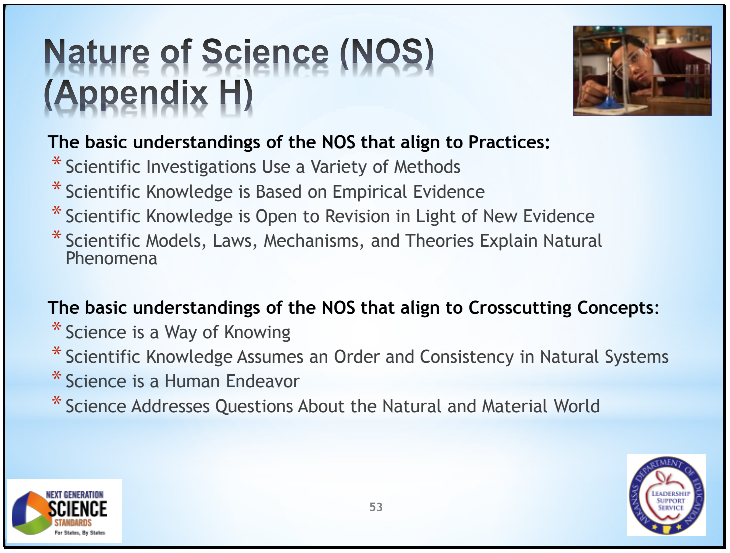

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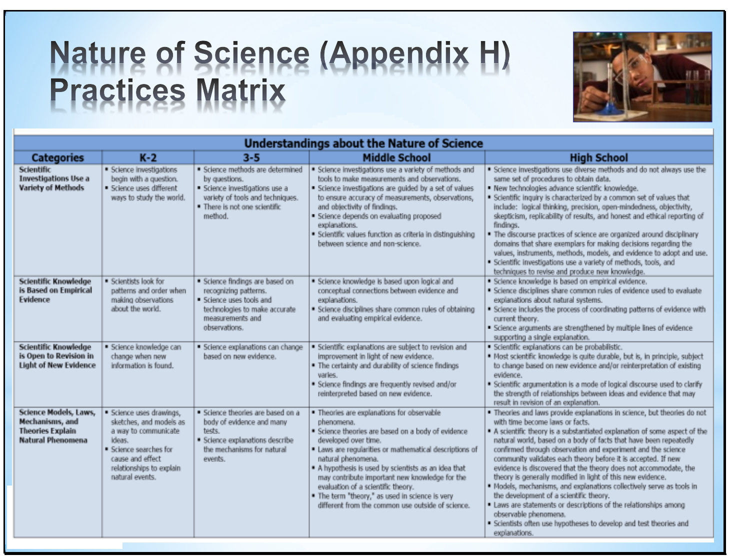

Understandings about the Nature of Science				
Categories	**K-2**	**3-5**	**Middle School**	**High School**
Scientific Investigations Use a Variety of Methods	▪ Science investigations begin with a question. ▪ Science uses different ways to study the world.	▪ Science methods are determined by questions. ▪ Science investigations use a variety of tools and techniques. ▪ There is not one scientific method.	▪ Science investigations use a variety of methods and tools to make measurements and observations. ▪ Science investigations are guided by a set of values to ensure accuracy of measurements, observations, and objectivity of findings. ▪ Science depends on evaluating proposed explanations. ▪ Scientific values function as criteria in distinguishing between science and non-science.	▪ Science investigations use diverse methods and do not always use the same set of procedures to obtain data. ▪ New technologies advance scientific knowledge. ▪ Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. ▪ The discourse practices of science are organized around disciplinary domains that share exemplars for making decisions regarding the values, instruments, methods, models, and evidence to adopt and use. ▪ Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
Scientific Knowledge is Based on Empirical Evidence	▪ Scientists look for patterns and order when making observations about the world.	▪ Science findings are based on recognizing patterns. ▪ Science uses tools and technologies to make accurate measurements and observations.	▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations. ▪ Science disciplines share common rules of obtaining and evaluating empirical evidence.	▪ Science knowledge is based on empirical evidence. ▪ Science disciplines share common rules of evidence used to evaluate explanations about natural systems. ▪ Science includes the process of coordinating patterns of evidence with current theory. ▪ Science arguments are strengthened by multiple lines of evidence supporting a single explanation.
Scientific Knowledge is Open to Revision in Light of New Evidence	▪ Science knowledge can change when new information is found.	▪ Science explanations can change based on new evidence.	▪ Scientific explanations are subject to revision and improvement in light of new evidence. ▪ The certainty and durability of science findings varies. ▪ Science findings are frequently revised and/or reinterpreted based on new evidence.	▪ Scientific explanations can be probabilistic. ▪ Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. ▪ Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	▪ Science uses drawings, sketches, and models as a way to communicate ideas. ▪ Science searches for cause and effect relationships to explain natural events.	▪ Science theories are based on a body of evidence and many tests. ▪ Science explanations describe the mechanisms for natural events.	▪ Theories are explanations for observable phenomena. ▪ Science theories are based on a body of evidence developed over time. ▪ Laws are regularities or mathematical descriptions of natural phenomena. ▪ A hypothesis is used by scientists as an idea that may contribute important new knowledge for the evaluation of a scientific theory. ▪ The term "theory," as used in science is very different from the common use outside of science.	▪ Theories and laws provide explanations in science, but theories do not with time become laws or facts. ▪ A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. ▪ Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. ▪ Laws are statements or descriptions of the relationships among observable phenomena. ▪ Scientists often use hypotheses to develop and test theories and explanations.

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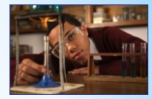
Nature of Science (Appendix H) Crosscutting Concepts Matrix



Understandings about the Nature of Science				
Categories	**K-2**	**3-5**	**Middle School**	**High School**
Science is a Way of Knowing	▪ Science knowledge helps us know about the world.	▪ Science is both a body of knowledge and processes that add new knowledge. ▪ Science is a way of knowing that is used by many people.	▪ Science is both a body of knowledge and the processes and practices used to add to that body of knowledge. ▪ Science knowledge is cumulative and many people, from many generations, and nations have contributed to science knowledge. ▪ Science is a way of knowing used by many people, not just scientists.	▪ Science is both a body of knowledge that represents current understanding of natural systems and the processes used to refine, elaborate, revise, and extend this knowledge. ▪ Science is a unique way of knowing and there are other ways of knowing. ▪ Science distinguishes itself from other ways of knowing through use of empirical standards, logical arguments, and skeptical review. ▪ Science knowledge has a history that includes the refinement of, and changes to, theories, ideas, and beliefs over time.
Scientific Knowledge Assumes an Order and Consistency in Natural Systems	▪ Science assumes natural events happen today as they happened in the past. ▪ Many events are repeated.	▪ Science assumes consistent patterns in natural systems. ▪ Basic laws of nature are the same everywhere in the universe.	▪ Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. ▪ Science carefully considers and evaluates anomalies in data and evidence.	▪ Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. ▪ Science assumes the universe is a vast single system in which basic laws are consistent.
Science is a Human Endeavor	▪ People have practiced science for a long time. ▪ Men and women are scientists and engineers.	▪ Men and women choose careers as scientists and engineers. ▪ Most scientists and engineers work in teams. ▪ Science affects everyday life. ▪ Creativity and imagination are important to science.	▪ Men and women from different social, cultural, and ethnic backgrounds work as scientists and engineers. ▪ Scientists and engineers rely on human qualities such as persistence, precision, reasoning, logic, imagination, and creativity. ▪ Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. ▪ Advances in technology influence the progress of science and science has influenced advances in technology.	▪ Scientific knowledge is a result of human endeavors, imagination, and creativity. ▪ Individuals and teams from many nations and cultures have contributed to science and engineering advances. ▪ Scientists' backgrounds, theoretical commitments, and fields of endeavor influence the nature of their findings. ▪ Technological advances have influenced the progress of science and science has influenced advances in technology. ▪ Science and engineering are influenced by society and society is influenced by science and engineering.
Science Addresses Questions About the Natural and Material World.	▪ Scientists study the natural and material world.	▪ Science findings are limited to questions that can be answered with empirical evidence.	▪ Scientific knowledge is constrained by human capacity, technology, and materials. ▪ Science limits its explanations to systems that lend themselves to observation and empirical evidence. ▪ Science knowledge can describe consequences of actions but does not make the decisions that society takes.	▪ Not all questions can be answered by science. ▪ Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. ▪ Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. ▪ Many decisions are **not** made using science alone, but rely on social and cultural contexts to resolve issues.

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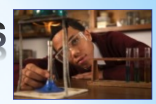
Engineering Design in the NGSS (Appendix I)



A foundation in engineering design allows students to better engage in and aspire to solve the major societal and environmental challenges they will face in the decades ahead.

Go to the DCI arrangement of the NGSS

- K-2 – page 21
- 3-5 – page 46
- Middle school – page 67
- High school – page 95

Discuss Engineering Design PEs – denoted with an *

NEXT GENERATION SCIENCE STANDARDS For States, By States

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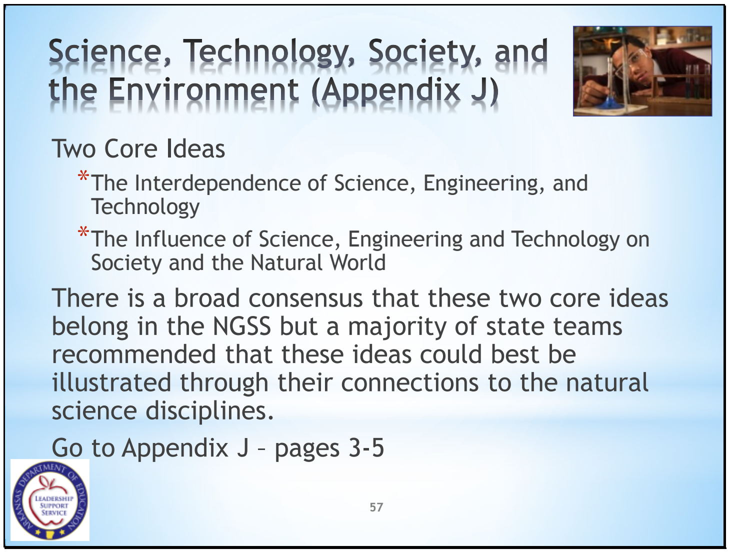

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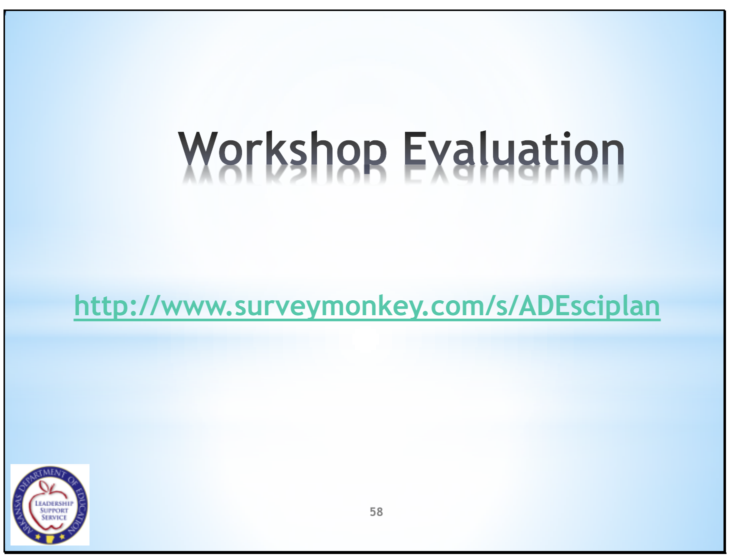

Host should tell the participants to identify themselves by their school district.

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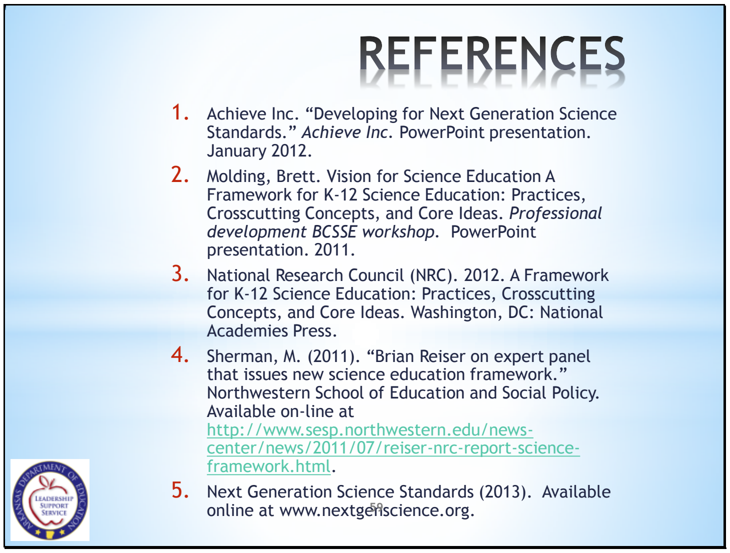

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