Introduction to the

NEXT GENERATION SCIENCE STANDARDS

SOUTH REGIONAL CABE CONFERENCE

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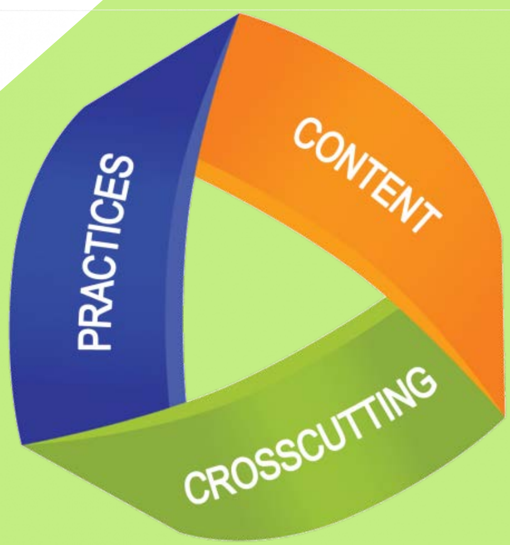
PRESENTATION OUTLINE

1. History of the NGSS
2. Organization of the NGSS
3. Structure of the NGSS
4. Implementation Pathway Model
5. Science Lesson Plan Structure*
6. Paper: "Language demands and opportunities in relation to Next Generation Science Standards for English Language Learners: What teachers need to know"*

History of the NGSS

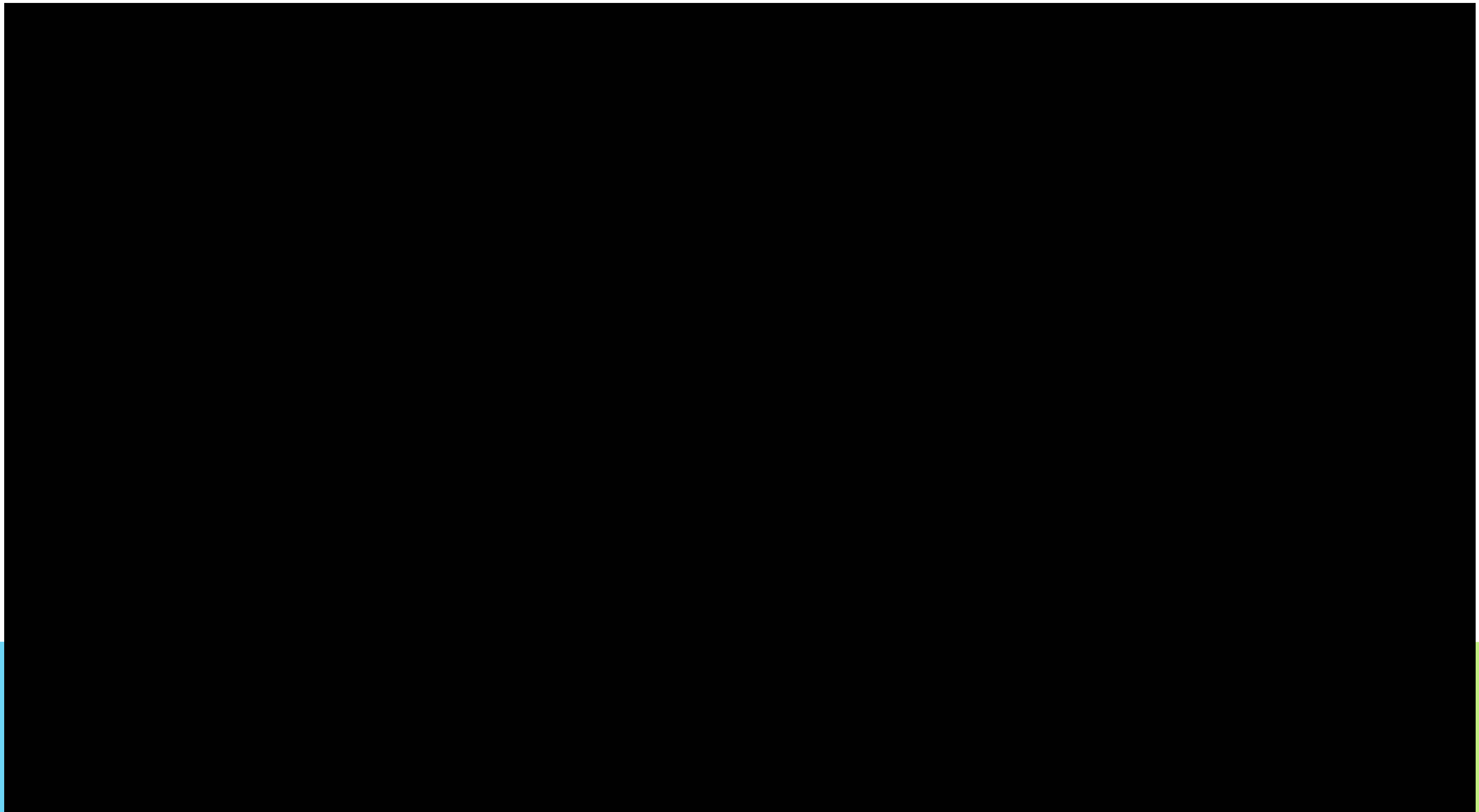


HISTORY OF THE NGSS

- Prior to the NGSS, the state of California used the "Science Content Standards for California Public Schools K-12" (1998)
- Since then, new research has been presented about the ways we learn science
    - affects the way we should be teaching science
- The groups that got together to begin the conversation of the new standards were:
    - National Research Council (NRC)
    - National Science Teachers Association (NSTA)
    - American Association for the Advancement of Science (AAAS)
    - Achieve

http://www.nextgenscience.org/development-overview

FRAMEWORK: THE VISION



THE SHIFT

SCIENCE EDUCATION WILL INVOLVE LESS:	SCIENCE EDUCATION WILL INVOLVE MORE:
Rote memorization of facts and terminology	Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based arguments and reasoning
Learning of ideas disconnected from questions about phenomena	Systems thinking and modeling to explain phenomena and to give a context for the ideas to be learned
Teachers providing information to the whole class	Students conducting investigations, solving problems, and engaging in discussions with teacher's guidance
Teachers posing questions with only one right answer	Students discussing open-ended questions that focus on the strength of the evidence used to generate claims

National Research Council 2015

THE SHIFT

SCIENCE EDUCATION WILL INVOLVE LESS:	SCIENCE EDUCATION WILL INVOLVE MORE:
Worksheets	Student writing of journals, reports, posters, and media presentations that explain and argue
Students reading textbooks and answering questions at the end of the chapter	Students reading multiple sources, including science-related magazine and journal articles and web-based resources; students developing summaries of information
Pre-planned outcome for “cookbook” laboratories or hands-on activities	Multiple investigations driven by students’ questions with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas
Oversimplification of activities for students who are perceived to be less able to do science and engineering	Provision of supports so that all students can engage in sophisticated science and engineering practices

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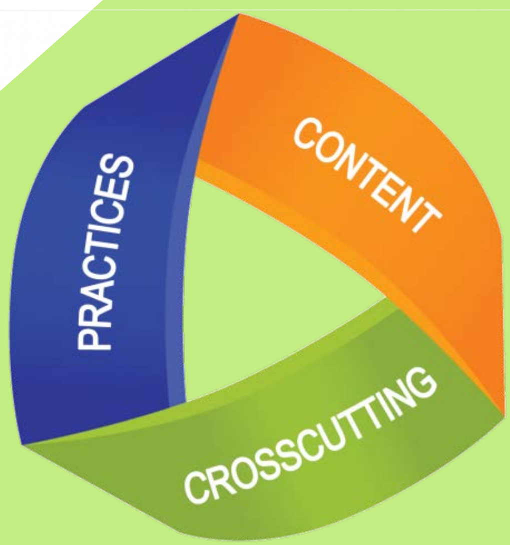
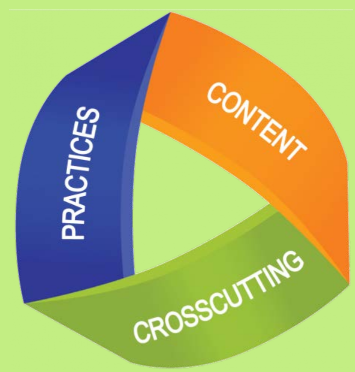
NEXT GENERATION SCIENCE STANDARDS

Organization of the NGSS



THE THREE DIMENSIONS OF NGSS

1. Scientific and Engineering Practices
2. Crosscutting Concepts
3. Disciplinary Core Ideas



DIMENSION 1: PRACTICES

- Scientific and engineering practices are needed to engage in investigations

- Previous standards referred to these as "skills;" however "skills" do not take into account the fact that specific knowledge is also required in order to perform a scientific investigation.

DIMENSION 1: PRACTICES

- **Eight behaviors/practices are required**
  - depending on whether the investigation has a scientific or engineering approach, the practice looks different

1. Question asking and problem definition
2. Model development and usage*
3. Planning and conducting investigations
4. Data analysis and interpretation
5. Mathematical and computations thought process
6. Solution design and creating explanations*
7. Participating in evidence-based argumentation*
8. Obtaining, evaluating and communicating information*

DIMENSION 2: CROSSCUTTING CONCEPTS

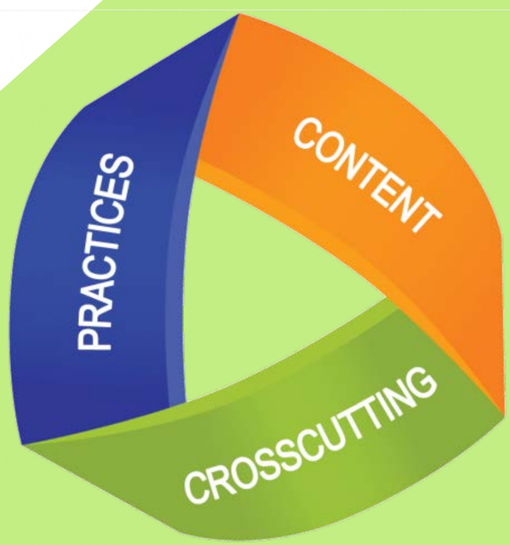
The second dimension of the NGSS holds the seven crosscutting concepts that are the means through which information is ordered.

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and quantity
4. Systems and System values
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

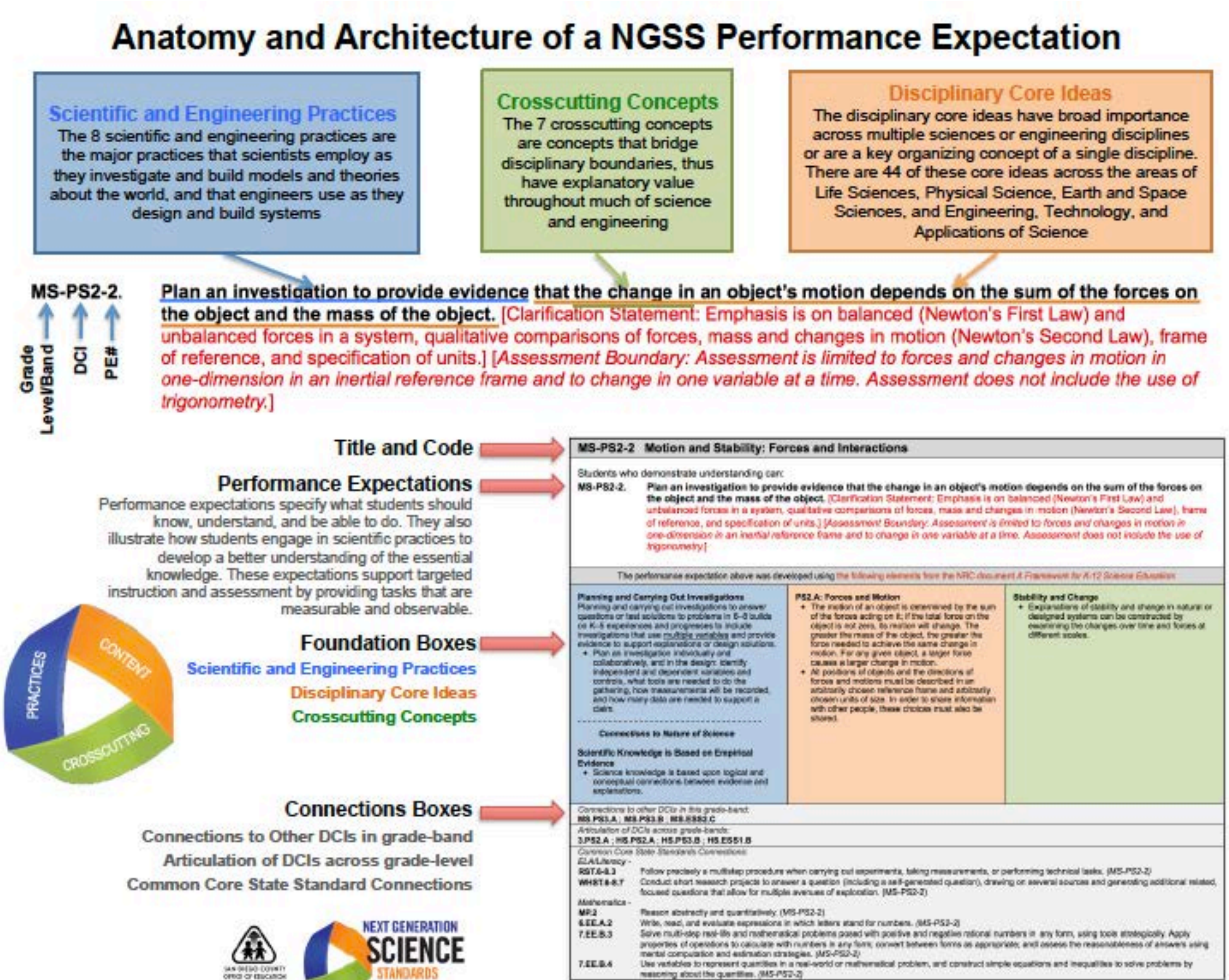
DIMENSION 3: DISCIPLINARY CORE IDEAS

- Have a broad importance across multiple sciences or engineering disciplines or
- Are a key organizing concept of a single discipline
- There are 44 core ideas across the areas of Life Sciences, Physical Science, Earth and Space Sciences, and Engineering, Technology, and Applications of Science

Structure of the NGSS



READING THE NGSS: ANATOMY AND ARCHITECTURE



READING THE NGSS: ABBREVIATIONS AND CODES

Abbreviations and Codes

Science and Engineering Practices (SEPs)

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas (DCIs)

Physical Sciences
PS1: Matter and its interactions
PS2: Motion and stability: Forces and interactions
PS3: Energy
PS4: Waves and their applications in technologies for information transfer

Life Sciences
LS1: From molecules to organisms: Structures and processes
LS2: Ecosystems: Interactions, energy, and dynamics
LS3: Heredity: Inheritance and variation of traits
LS4: Biological evolution: Unity and diversity

Earth and Space Science
ESS1: Earth's place in the universe
ESS2: Earth's systems
ESS3: Earth and human activity

Engineering, Technology, and Applications of Science
ETS1: Engineering design
ETS2: Links among engineering, technology, science, and society

Crosscutting Concepts (CCCs)

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

ELA/Literacy

R – Reading
- RL – Reading: Literature
- **RI** – Reading: Informational Text
- RF – Reading: Foundational Skills

W – Writing
SL – Speaking and Listening
L – Language
RST – Reading Science and Technical Subjects
WHST – Writing History, Science and Technical Subjects

Mathematics: K-8

CC – Counting and Cardinality
OA – Operations and Algebraic Thinking
NBT – Numbers & Operations in Base Ten
NF – Numbers & Operations-Fractions
MD – Measurement & Data
G – Geometry
RP – Ratio & Proportional Relationships
NS – The Number System
EE – Expressions & Equations
SP – Statistics & Probability
F – Functions
MP – Standards for Mathematical Practice

Mathematics: High School

Number & Quantity
N-RN – The Real Number System
N-Q – Quantities
N-CN – The Complex Number System
N-VM – Vector and Matrix Quantities

Algebra
A-SSE – Seeing Structure in Equations
A-APR – Arithmetic with Polynomials and Rational Expressions
A-CED – Creating Equations
A-REI – Reasoning with Equations and Inequalities

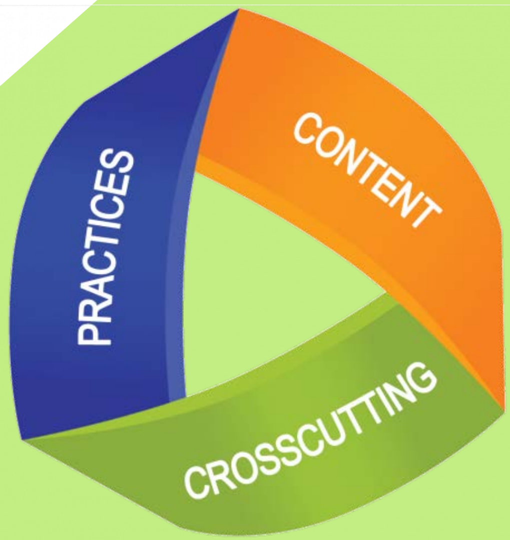
Functions
F-IF – Interpreting Functions
F-BF – Building Functions
F-LE – Linear, Quadratic and Exponential Models
F-TF – Trigonometric Functions

Geometry
G-CO – Congruence
G-SRT – Similarity, Right Triangles, & Trigonometry
G-C – Circles
G-GPE – Expressing Geometric Properties with Equations
G-GMD – Geometric Measurement & Dimension
G-MG – Modeling with Geometry

Statistics and Probability
S-ID – Interpreting Categorical & Quantitative Data
S-IC – Making Inferences & Justifying Conclusions
S-CP – Conditional Probability and Rules of Probability
S-MD – Using Probability to Make Decisions

Information on this document is adapted from information at nextgenscience.org and www.corestandards.org by J. Spiegel, San Diego County Office of Education.

Implementation of the NGSS



IMPLEMENTING THE NGSS

- The California Department of Education drafted the *Next Generation Science Standards Implementation Plan for California*
- The three phases are:
    1. Awareness
    2. Transition
    3. Implementation

Spiegel, J., Quan, A., & Shimojy, Y. (2014). Planning Professional Learning Using the NGSS Implementation Pathway Model. *California Science Teachers Association*, *27*(7).

Figure 1: Phases of NGSS Implementation

The draft *Next Generation Science Standards Implementation Plan for California* outlines the three phases of implementation as:

- The **Awareness** phase represents an introduction to the CA NGSS, the initial planning of systems implementation, and establishment of collaborations.
- The **Transition** phase is the concentration on building foundational resources, implementing needs assessments, establishing new professional learning opportunities, and expanding collaborations between all stakeholders.
- The **Implementation** phase expands the new professional learning support, fully aligns curriculum, instruction, and assessments, and effectively integrates these elements across the field.

Spiegel, J., Quan, A., & Shimojy, Y. (2014). Planning Professional Learning Using the NGSS Implementation Pathway Model. *California Science Teachers Association*, *27*(7).

THE NGSS IMPLEMENTATION PATHWAY MODEL (SPIEGEL, ET AL., 2014)

Figure 2. The NGSS Implementation Pathway Model

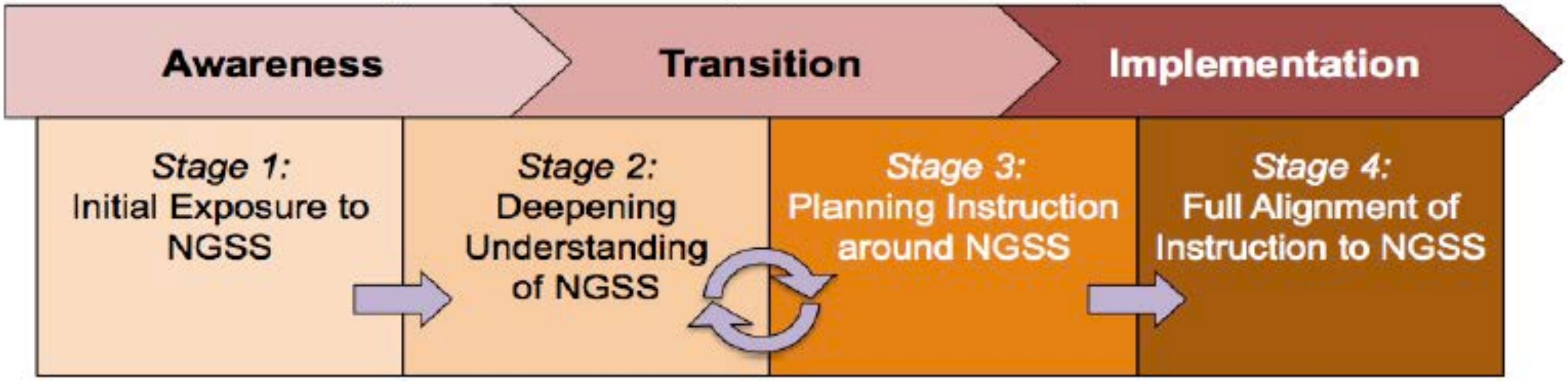


Figure 3. Stages in the NGSS Implementation Pathway Model

Stage 1 **Initial Exposure to NGSS**	**Stage 2** **Deepening Understanding of NGSS**	**Stage 3** **Planning Instruction around NGSS**	**Stage 4** **Full Alignment of Instruction to NGSS**
Teachers are beginning to learn and become familiar with the Conceptual Shifts (Innovations), the three dimensions of learning, and the performance expectations of the NGSS	Teachers engage in on-going research and the building of personal understanding of the Conceptual Shifts (Innovations), the three dimensions of learning, and the performance expectations of the NGSS	Teachers begin planning lessons and units aligned to the three dimensions and performance expectations of the NGSS, returning to the previous stage as needed to ensure coherence with the Conceptual Shifts (Innovations) of the NGSS	Teachers design and plan instruction aligned to NGSS curriculum and assessment
Outcomes might include • Describe the Conceptual Shifts[5] (Innovations) of the NGSS and discuss implications for teaching and learning. • Identify the three-dimensions of the NGSS[5] • Explain the anatomy and architecture of a NGSS standard • Identify NGSS resources for further study and information	*Outcomes might include* • Express how teaching and learning look in the NGSS • For any standard, identify each of the dimensions connected to the performance expectation • Describe what a Science and Engineering Practice and Crosscutting Concept would look like in their classroom, providing examples of how they might engage students in these dimensions • For a performance expectation, identify a possible performance task that would assess student learning around the performance expectation	*Outcomes might include* • Review grade level or subject area performance expectations • Take a current lesson/unit and translate it to the NGSS • Using the BSCS 5E Instructional Model or similar model, plan a learning cycle that integrates the three dimensions of the NGSS • Identify and describe a performance task that could be used in the classroom to assess student performance and understanding around a performance expectation or multiple performance expectations	*Outcomes might include* • Implement formative and summative assessments aligned to NGSS • Create curriculum maps or implement district curriculum guides • Implement NGSS adopted curriculum that is aligned to AIM, EQuiP, or similar rubrics

J. Spiegel and K. Bess (San Diego County Office of Education), Y. Shimojyo (Riverside County Office of Education), A. Quan (Los Angeles County Office of Education). 2014.

Science Lesson Plan Structure

THE BSCS 5E INSTRUCTIONAL MODEL

BY RODGER W. BYBEE

FIGURE 1.

Summary of the BSCS 5Es instructional model.

Engagement
The teacher or a curriculum task helps students become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.

Exploration
Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions, and design and conduct an investigation.

Explanation
The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. In this phase teachers directly introduce a concept, process, or skill. An explanation from the teacher or other resources may guide learners toward a deeper understanding, which is a critical part of this phase.

Elaboration
Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept and abilities by conducting additional activities.

Evaluation
The evaluation phase encourages students to assess their understanding and abilities and allows teachers to evaluate student progress toward achieving the learning outcomes.

Teacher and Student Activities in the BSCS 5E Instructional Model

5E Stage	Student Behaviors	Teaching Strategies
Engage Initiates the learning task, accesses prior knowledge, and organizes student thinking toward outcomes of current activities.	• Asks questions such as, Why did this happen? What do I already know about this? What can I find out about this? How can this problem be solved? • Shows interest in the topic. • Engages in problem, expresses own ideas.	• Raises questions or problems. • Elicits responses that uncover students' current knowledge about the concept/topic. • Helps students make connections to previous work. • Posts learning outcomes and explicitly references them in the lesson.
Explore Common base of experiences within which concepts, processes, and skills are developed.	• Test predictions and hypotheses. Forms new predictions and hypotheses. • Discusses problems with others. • Records observations and ideas.	• Provides question or problem. • Provides common experience. • Observes and listens to students as they interact. • Acts as a consultant for students.
Explain Students demonstrate their understanding. Teacher provides resources and information to support student learning. Formal definitions and scientists' details are provided.	• Explains possible solutions or answers to other students. • Listens critically to and questions other explanations. • Listens to explanations offered by the teacher. • Refers to investigation. • Uses evidence from investigation in explanations.	• Encourages students to explain concepts and definitions in their own words. • Asks for justification (evidence) and clarification from students. • Formally provides definitions, explanations, and new vocabulary through mini lecture, text, internet, or other resources. • Builds on student explanations.
Elaborate Students' understanding is challenged and extended, skills further developed. Application of knowledge to new situations.	• Applies new labels, definitions, explanations, and skills in new, but similar, situations. • Uses previous information to ask questions, propose solutions, make decisions, design experiments, or complete a challenge. • Draws reasonable conclusions from evidence. • Records observations and explanations.	• Expects students to use vocabulary, definitions, and explanations provided previously in new context. • Encourages students to apply the concepts and skills in new situations. • Provide alternative explanations.
Evaluate Teacher and students assess understanding and skills. Assessment is formal and informal, summative and formative.	• Student gives another student feedback. • Evaluates his or her progress or knowledge. • Checks work with a rubric.	• Asks open-ended questions such as, "Why do you think...?" "What evidence do you have?" "How would you answer the question?" • Observe students. • Gathers evidence of student understanding. • Variety of assessments.

J. Spiegel, 2013, San Diego County Office of Education

LESSON PLAN TEMPLATE: SAMPLE LESSON

DLE 912 Lesson Plan Template

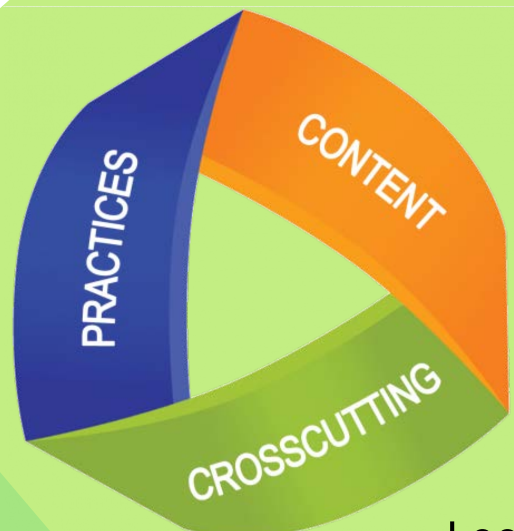
Lesson Name: Circuitos
Grade Level(s): 4º

Your name and Red ID: Melissa Navarro
Duration of Lesson: 1 hora

NGSS:
4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another

Guiding Inquiry Question:
¿Qué es lo que causa que se prenda un foco?
Lesson Objectives:
1. Nosotros crearemos un circuito simple y lograremos hacer prender un foco 2. Nosotros agregaremos un interruptor a un circuito para lograr hacer prender un foco
Prior Skills/Knowledge Needed:
• Saber que es un foco • Comprender como funciona un interruptor • Estar familiarizado con la electricidad y con utilizar cables/alambres
Evaluate

“Language Demands and Opportunities in Relation to Next Generation Science Standards for English Language Learners: What Teachers Need to Know”



Lee, O., Quinn, H., & Valdes, G. (2012)

"Language Demands and Opportunities in Relation to Next Generation Science Standards for English Language Learners: What Teachers Need to Know"

Helen Quinn, *Stanford University*
Okhee Lee, *New York University*
Guadalupe Valdés, *Stanford University*

This paper discusses challenges and opportunities expected as English language learners (ELLs) engage with Next Generation Science Standards (NGSS). We subscribe to a view of language learning and proficiency that is most concerned with students' ability to use language to function in the context of their lives both in and out of school. We have discussed this view of second language acquisition and its implications for the science classroom in greater detail in a separate paper. Here, we concern ourselves with learning opportunities for ELLs in an English-speaking science classroom in which NGSS have been implemented based on the National Research Council (NRC, 2011) document "*A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*" (hereafter called "the Framework").

Lee, O., Quinn, H., & Valdes, G. (2012)

STRUCTURE OF THE PAPER

I. Introduction

II. Next Generation Science Standards: Focus on Science and Engineering Practices

Discusses the 3 dimensions of the NGSS

I. Intersection between Science Practices and Language Learning

Addresses issues of

1) language skills involved as students engage in science and engineering practices
2) Features of science text and science talk

I. Features of Science Language

Understanding features of science text and science talk

I. Supporting Science and Language Learning for ELLs

Five areas to support ELL's: literacy strategies with all students, language support strategies with ELL's, discourse strategies with ELL's, home language support and home culture connections

I. Language Support Strategies

Purposeful activities to communicate meaning in science

Lee, O., Quinn, H., & Valdes, G. (2012)

RECOMMENDATIONS

1. Do not fear the NGSS! ☺

2. Find which part of the implementation stage your school is in, and plan your next steps

3. Who are you collaborating with?

CONCLUSION

"To meet the outcomes identified in each stage of this model, teachers will need to dedicate significant effort in their own professional learning. Schools and districts will need to provide support and time for this learning to occur. It should be emphasized that all teachers in a school or district will not be at the same stage at any given time, thus there will be a need to differentiate professional learning for teachers in the coming months and years. In addition, the time needed to work through these stages should not be underestimated."

(Spiegel, et al., 2014)

Q & A

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REFERENCES AND RECOMMENDED READINGS

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