NEXT GENERATION SCIENCE STANDARDS

For States, By States

All Standards, All Students: Making NGSS Accessible to All Students

MRSEC Education Directors' Meeting

September 16, 2013

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New York University

Topics

- Student demographics and science achievement
- Next Generation Science Standards (NGSS)
  - ➢ Overview
  - ➢ Major themes in relation to diversity and equity
  - ➢ NGSS Diversity and Equity Team's charges

Student Demographics and Science Achievement

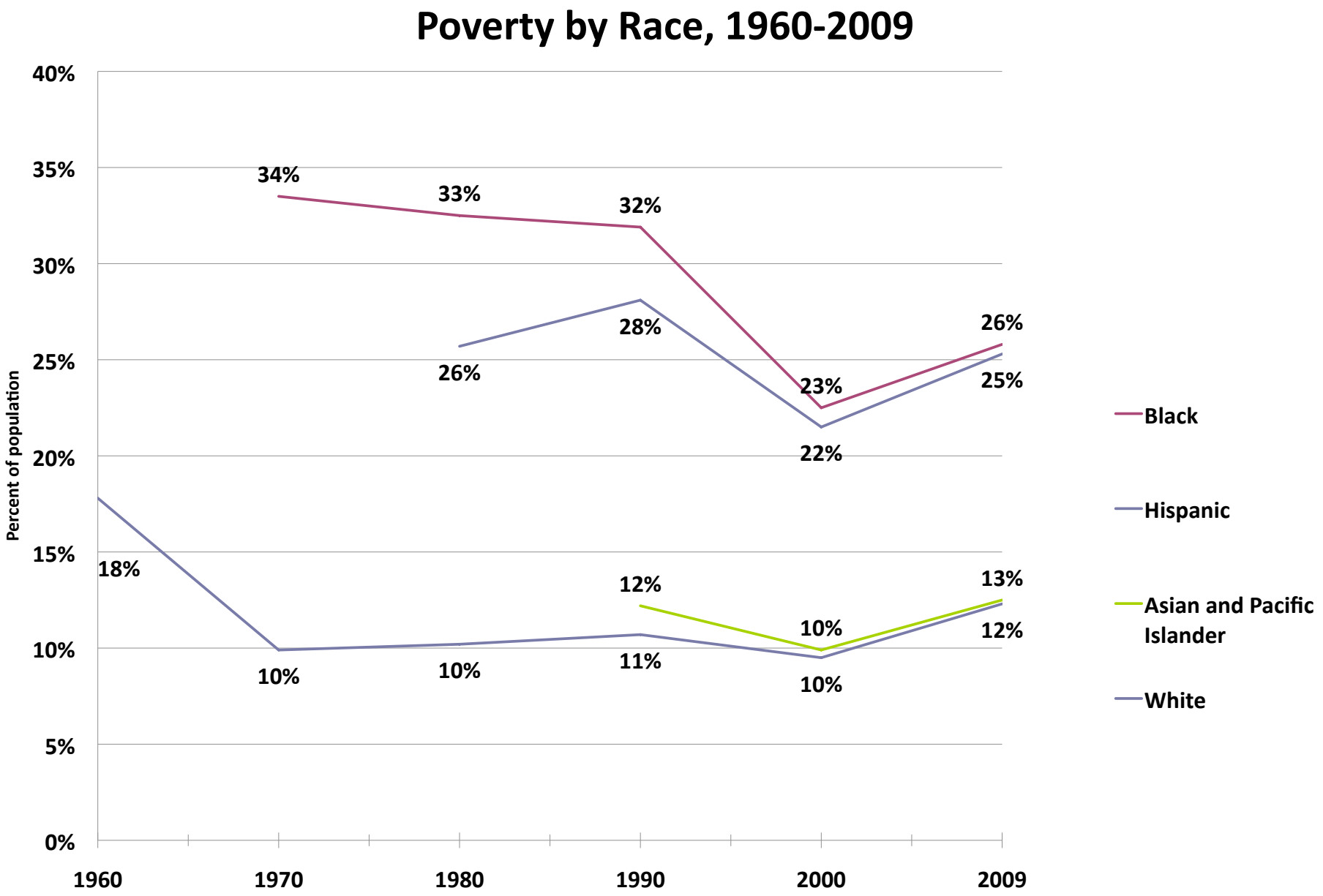
Four Accountability Groups (US Census)

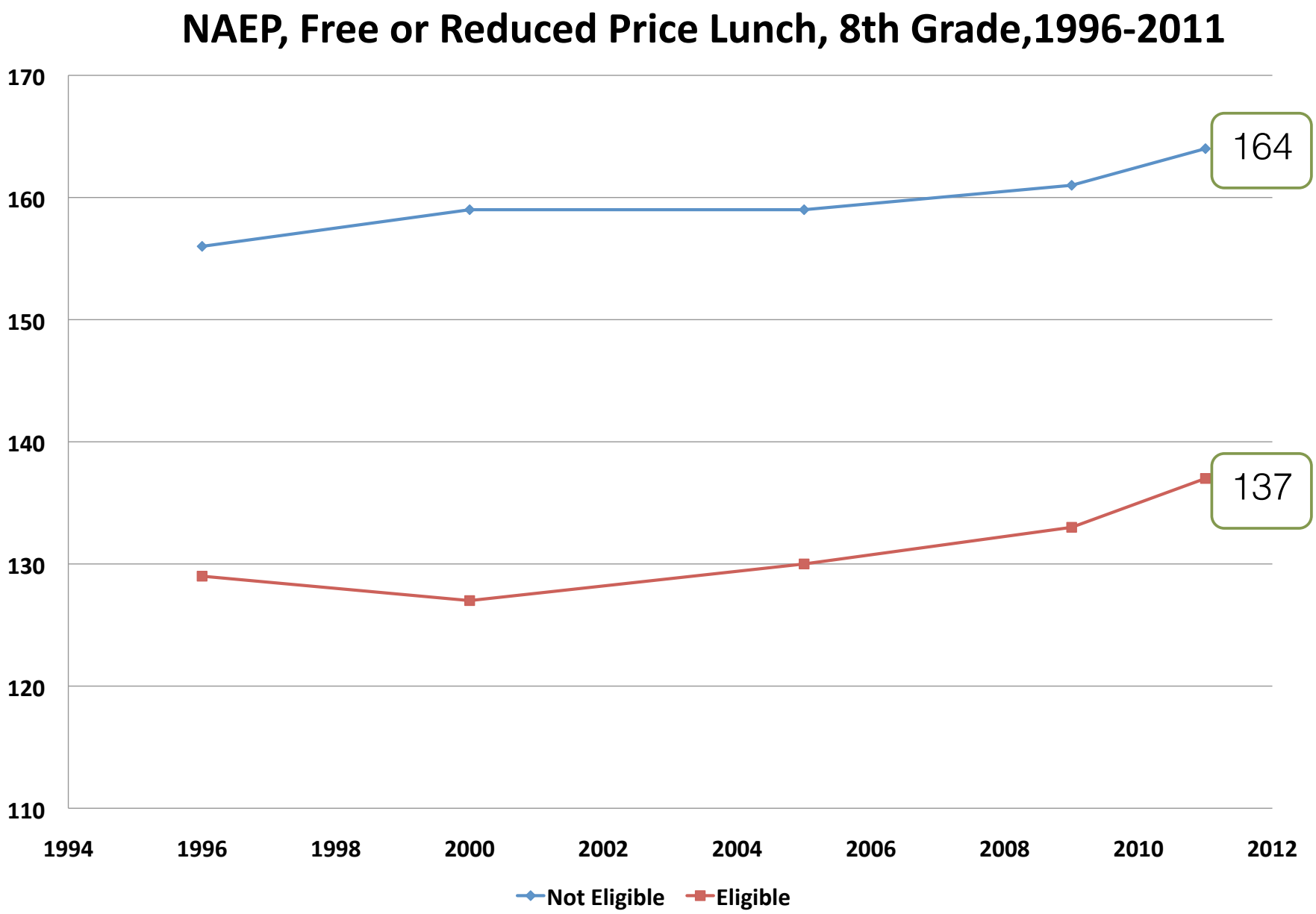
1. Economically disadvantaged students (Poverty)
2. Students from major racial and ethnic groups (Race)
3. Students with disabilities
4. Limited English proficient students

Poverty

- 22% of children live in poverty, the highest rate since the American Community Survey began in 2001 (2010 U.S. Census)
- About 1 in 5 public schools is considered high poverty in 2011, compared to about 1 in 8 schools in 2000
- 48% of students are eligible for free or reduced price lunch in 2010

(National Center for Education Statistics)

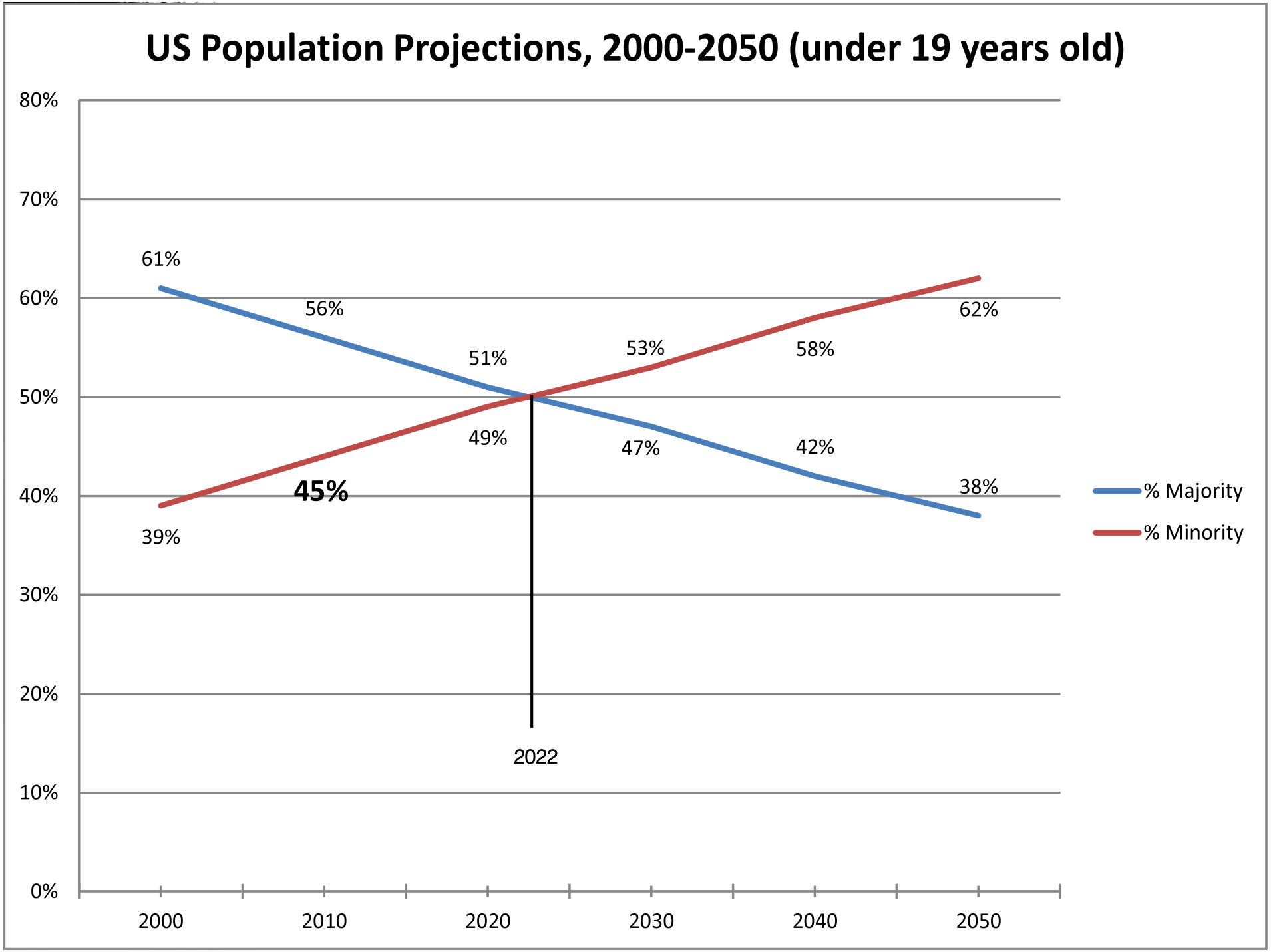

Poverty by Race, 1960-2009
Percent of population
40%
35%
30%
25%
20%
15%
10%
5%
0%
1960
1970
1980
1990
2000
2009
34%
33%
32%
23%
26%
26%
28%
22%
25%
18%
10%
10%
11%
10%
12%
12%
10%
13%
Black
Hispanic
Asian and Pacific Islander
White


NAEP, Free or Reduced Price Lunch, 8th Grade,1996-2011
170
160
150
140
130
120
110
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
164
137
Not Eligible
Eligible

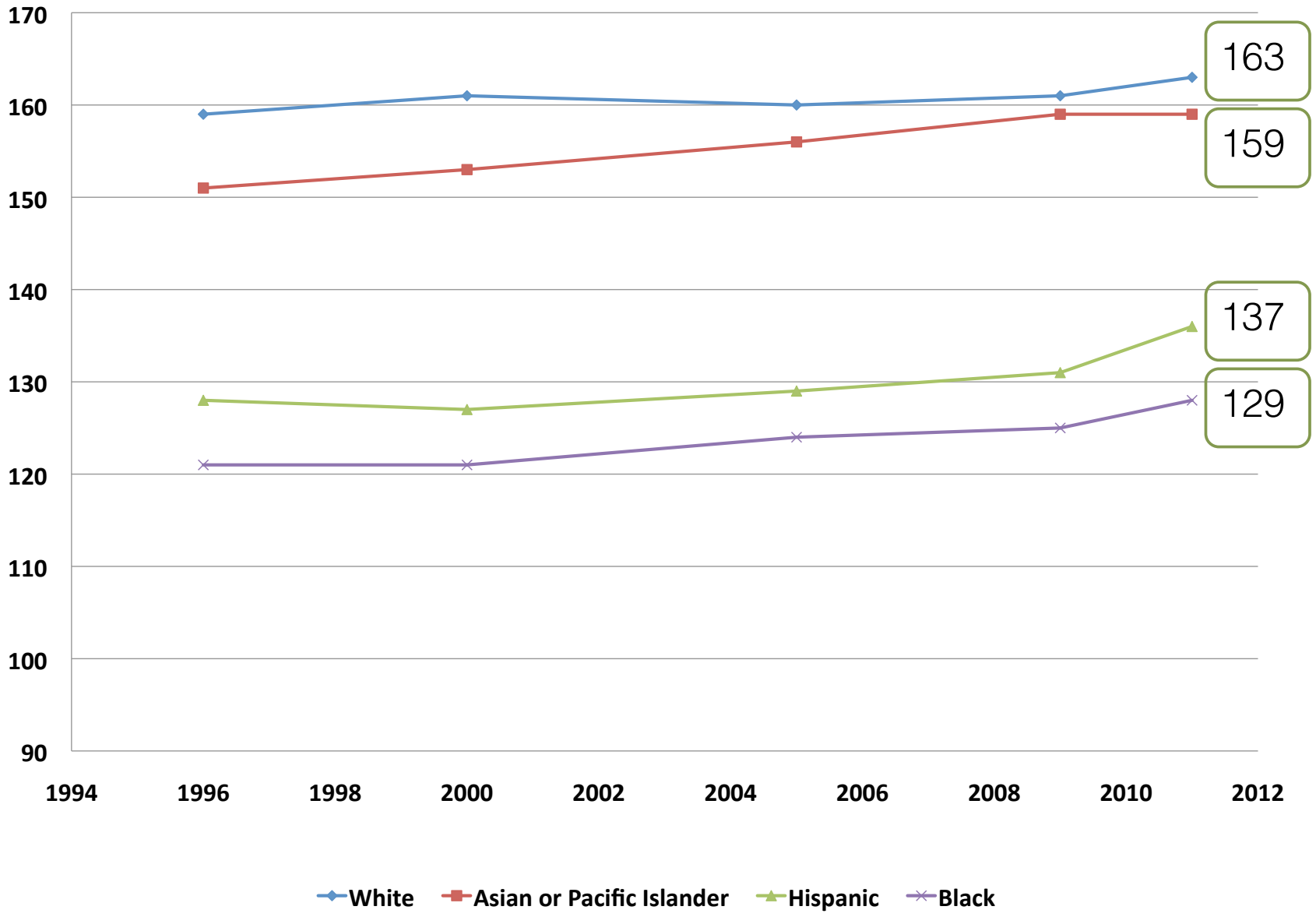
Race

- 36% of the U.S. population are racial minorities
- 45% of the U.S. population under 19 years old are racial minorities

  (2010 U.S. Census)

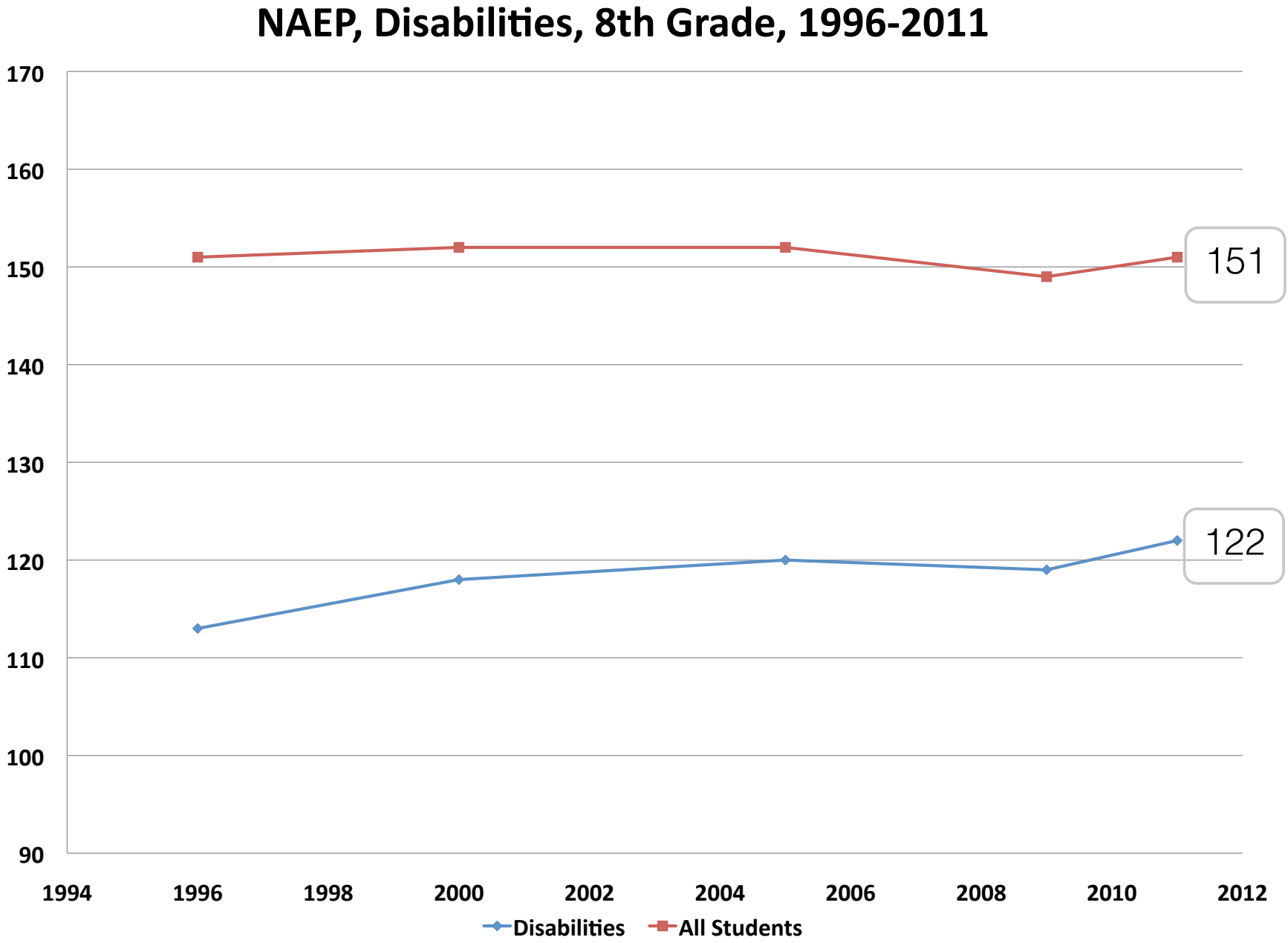

US Population Projections, 2000-2050 (under 19 years old)
80%
70%
60%
50%
40%
30%
20%
10%
0%
2000
2010
2020
2030
2040
2050
61%
56%
51%
47%
42%
38%
39%
45%
49%
53%
58%
62%
2022
% Majority
% Minority

NAEP, Race, 8th Grade, 1996-2011



Students with Disabilities

- Individuals with Disabilities Education Act (IDEA)
- 13% of children and youth ages 3-21 receive special education services under IDEA in 2009


NAEP, Disabilities, 8th Grade, 1996-2011
170
160
150
140
130
120
110
100
90
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
151
122
Disabilities
All Students

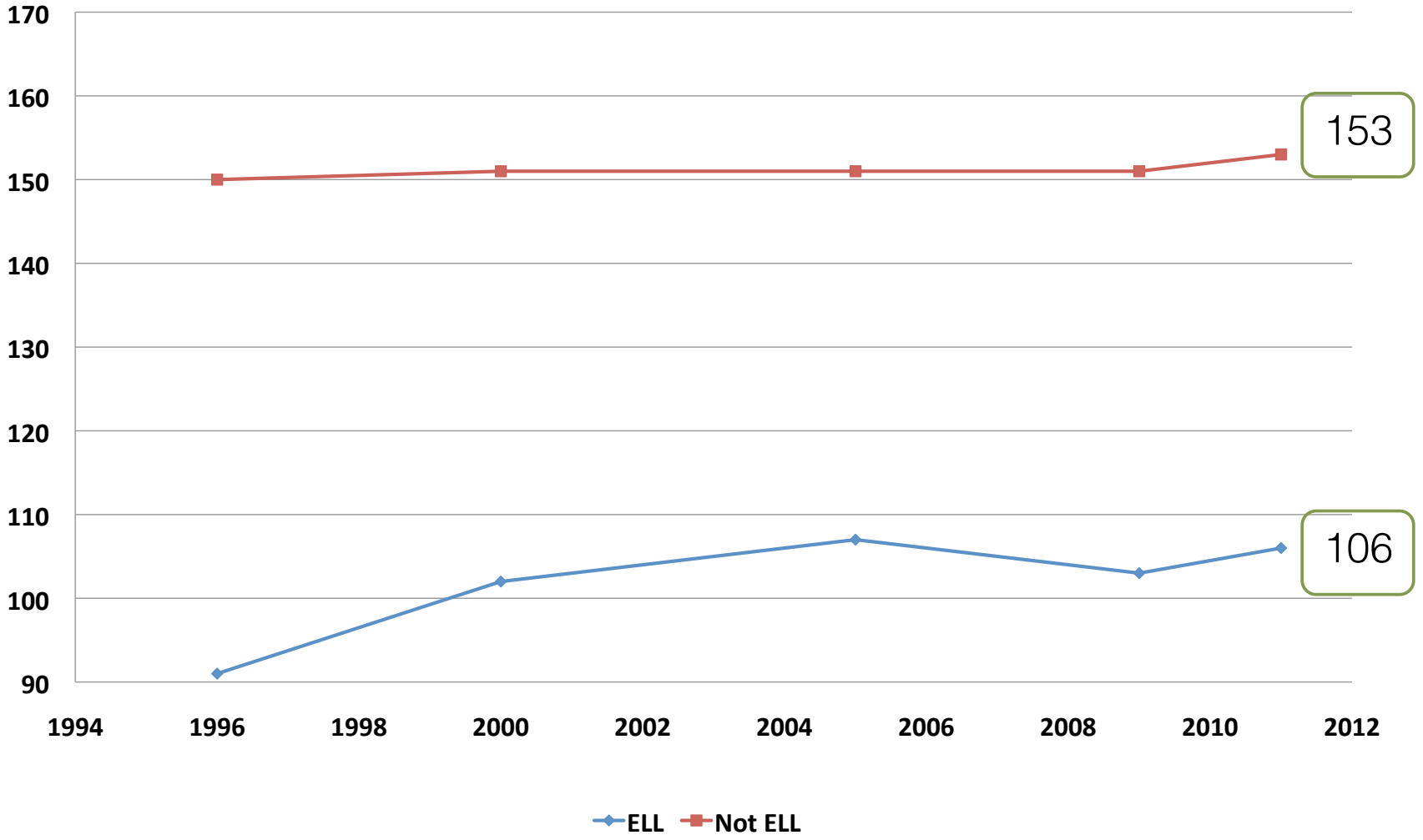
English Language Learners

- 21% of school age children speak a language other than English as their primary language at home in 2007

- Limited English Proficient (LEP) students (the federal term) have more than doubled from 5% in 1993 to 11% in 2007

  (National Center for Education Statistics)

NAEP, ELL, 8th Grade, 1996-2011



NEXT GENERATION SCIENCE STANDARDS

For States, By States

NGSS Diversity and Equity:

All Standards, All Students

Overview

- Achieve, Inc. oversaw the development
- The 41 writing team members consisted of classroom teachers, state and district supervisors, faculty from higher education institutions, and representatives from the private sector
- There were two rounds of public release of drafts for feedback – May 2012 and January 2013
- The final NGSS were released in April 2013

http://www.nextgenscience.org/

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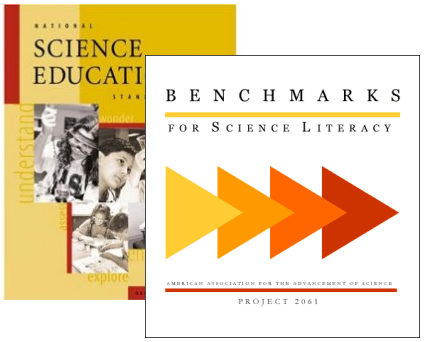
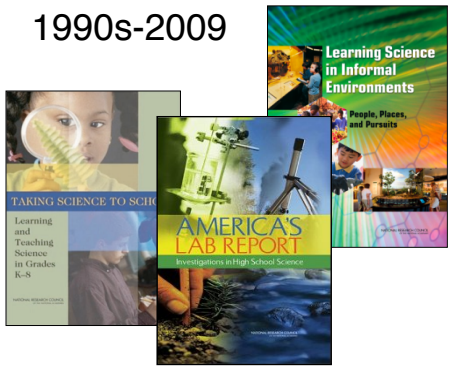
Building on the Past; Preparing for the Future

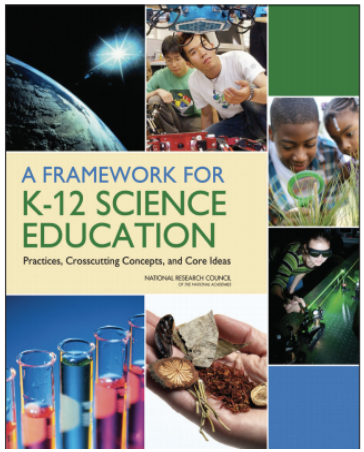


1990s

1990s-2009



Phase I



1/2010 - 7/2011

Phase II

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7/2011 – April 2013

Conceptual Shifts

1. K-12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real world.
2. The Next Generation Science Standards are student performance expectations – NOT curriculum.
3. The science concepts build coherently from K-12.
4. The NGSS focus on deeper understanding of content as well as application of content.
5. Science and engineering are integrated from K–12.
6. NGSS content is focused on preparing students for the next generation workforce.
7. The NGSS and Common Core State Standards for English language arts and mathematics are aligned.

NEXT GENERATION SCIENCE STANDARDS

Three Dimensions

Science & Engineering Practices

1. Ask questions (for science) and define problems (for engineering)
2. Develop and use models
3. Plan and carry out investigations
4. Analyze and interpret data
5. Use mathematics and computational thinking
6. Construct explanations (for science) and design solutions (for engineering)
7. Engage in argument from evidence
8. Obtain, evaluate, and communicate information

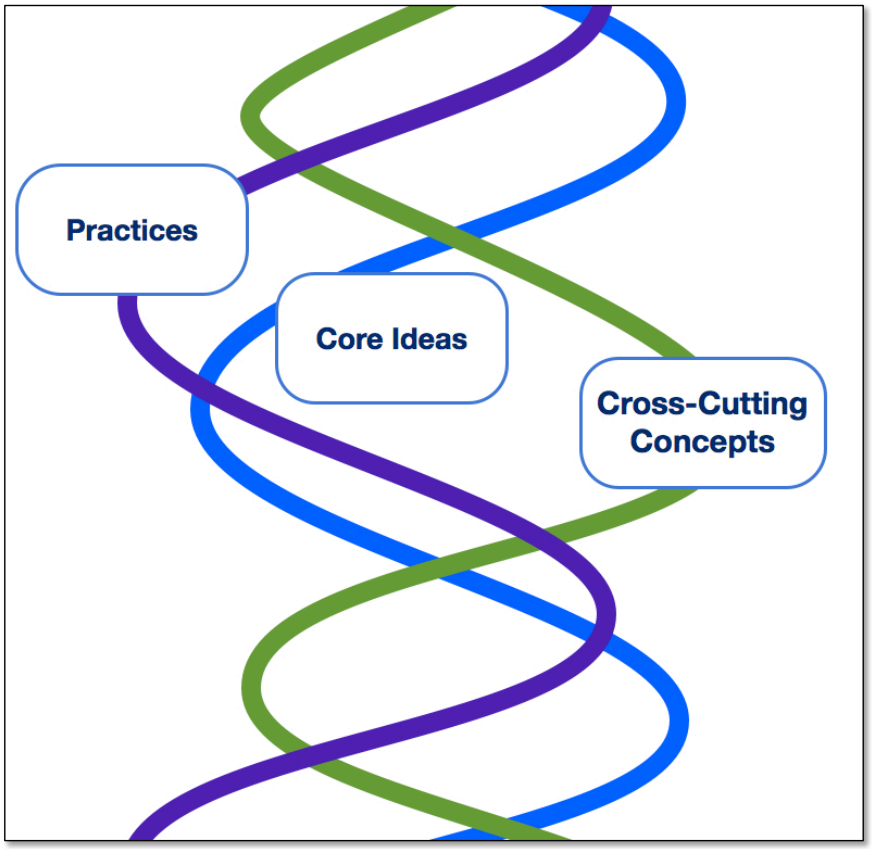
Crosscutting Concepts

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

Core Ideas

1. Physical Sciences
2. Life Sciences
3. Earth and Space Sciences
4. Engineering, Technology and Applications of Science

Three Dimensions Intertwined



- Science and engineering practices
- Crosscutting concepts
- Disciplinary core ideas

NEXT GENERATION SCIENCE STANDARDS
For States, By States

2-ESS2 Earth's Systems

2. Earth's Systems

Students who demonstrate understanding can:

2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.* [Clarification Statement: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.]

2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area. [Assessment Boundary: Assessment does not include quantitative scaling in models.]

2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.

- Develop a model to represent patterns in the natural world. (2-ESS2-2)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.

- Compare multiple solutions to a problem. (2-ESS2-1)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.

- Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question. (2-ESS2-3)

Disciplinary Core Ideas

ESS2.A: Earth Materials and Systems

- Wind and water can change the shape of the land. (2-ESS2-1)

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. (2-ESS2-2)

ESS2.C: The Roles of Water in Earth's Surface Processes

- Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. (2-ESS2-3)

ETS1.C: Optimizing the Design Solution

- Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (secondary to 2-ESS2-1)

Crosscutting Concepts

Patterns

- Patterns in the natural world can be observed. (2-ESS2-2),(2-ESS2-3)

Stability and Change

- Things may change slowly or rapidly. (2-ESS2-1)

Connections to Engineering, Technology, and Applications of Science
Influence of Engineering, Technology, and Science on Society and the Natural World

- Developing and using technology has impacts on the natural world. (2-ESS2-1)

Connections to Nature of Science
Science Addresses Questions About the Natural and Material World

- Scientists study the

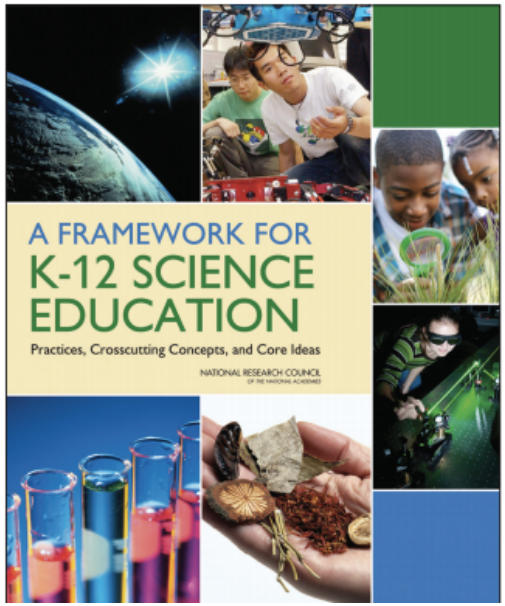
Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version.

Common Core State Standards Connections: [Note: these connections will be made available soon.]
ELA/Literacy –
Mathematics –

Work To Do –
State Adoption and Implementation

Completed



Completed

NEXT GENERATION SCIENCE STANDARDS

Work To Do

- Assessment
- Curricula
- Instruction
- Teacher Development
- Policy

NEXT GENERATION SCIENCE STANDARDS

NGSS Diversity and Equity: Major Themes

Theme 1: NGSS connections to CCSS

Theme 2: Practices

Theme 3: Engineering

Theme 4: Crosscutting concepts

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Theme 1: NGSS Connections to CCSS

- Raise the bar for content
  (see graphic on disciplinary practices)

- Call for a high level of classroom discourse across all content areas for all students

Understanding Language Initiative <http://ell.stanford.edu>

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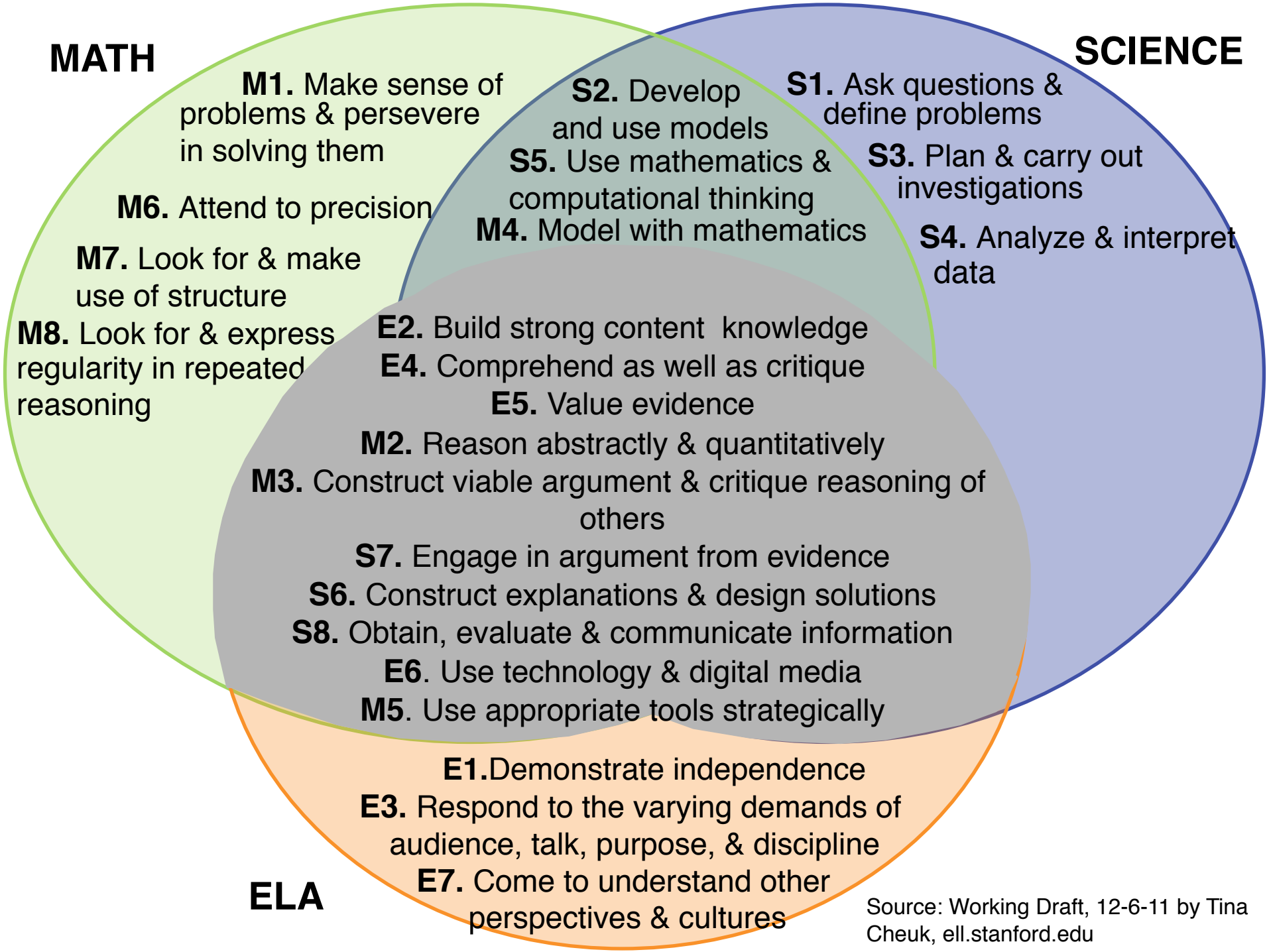

Source: Working Draft, 12-6-11 by Tina Cheuk, ell.stanford.edu

Theme 2: Practices

- Raise the bar for language
  (see graphic on language practices)

- Call for a high level of classroom discourse across all content areas for all students

Understanding Language Initiative <http://ell.stanford.edu>

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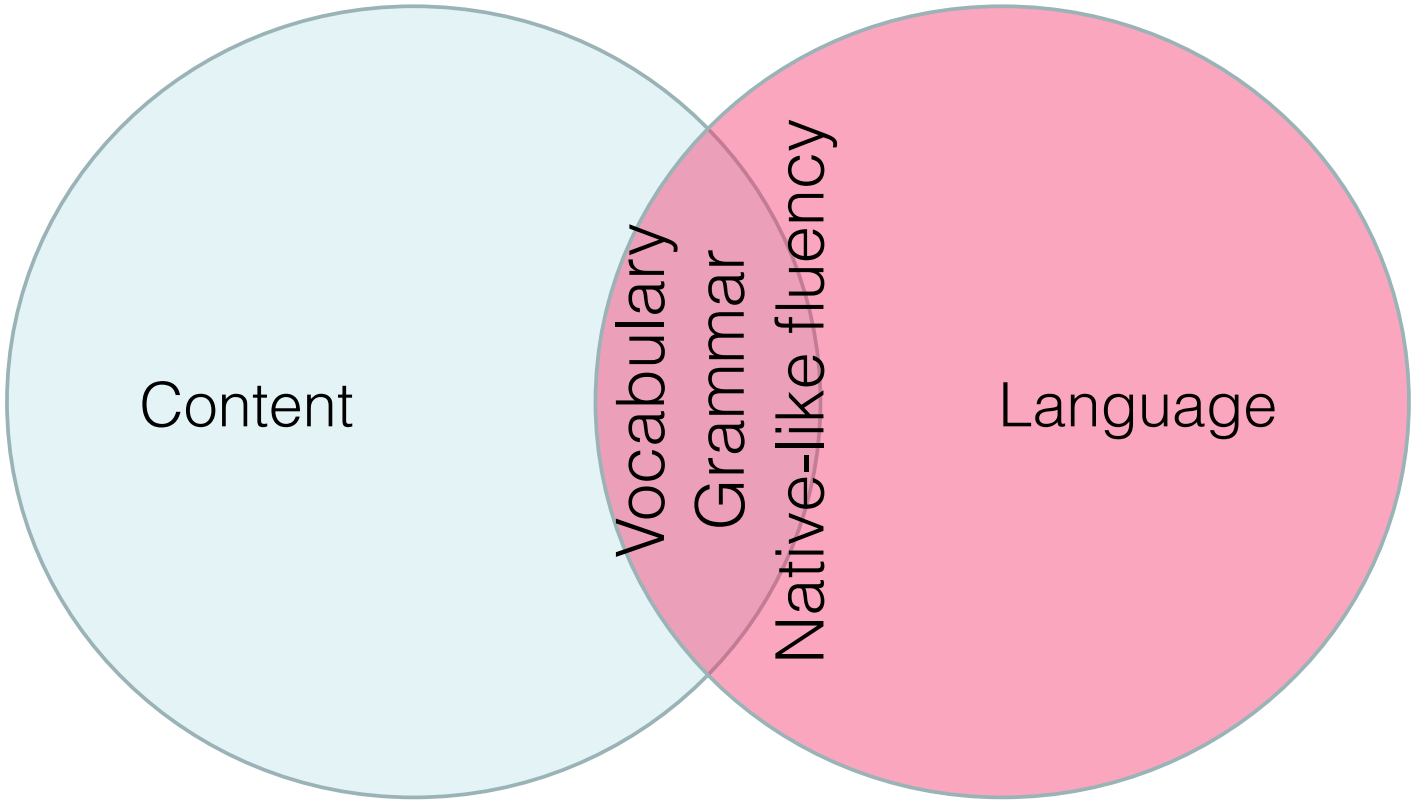
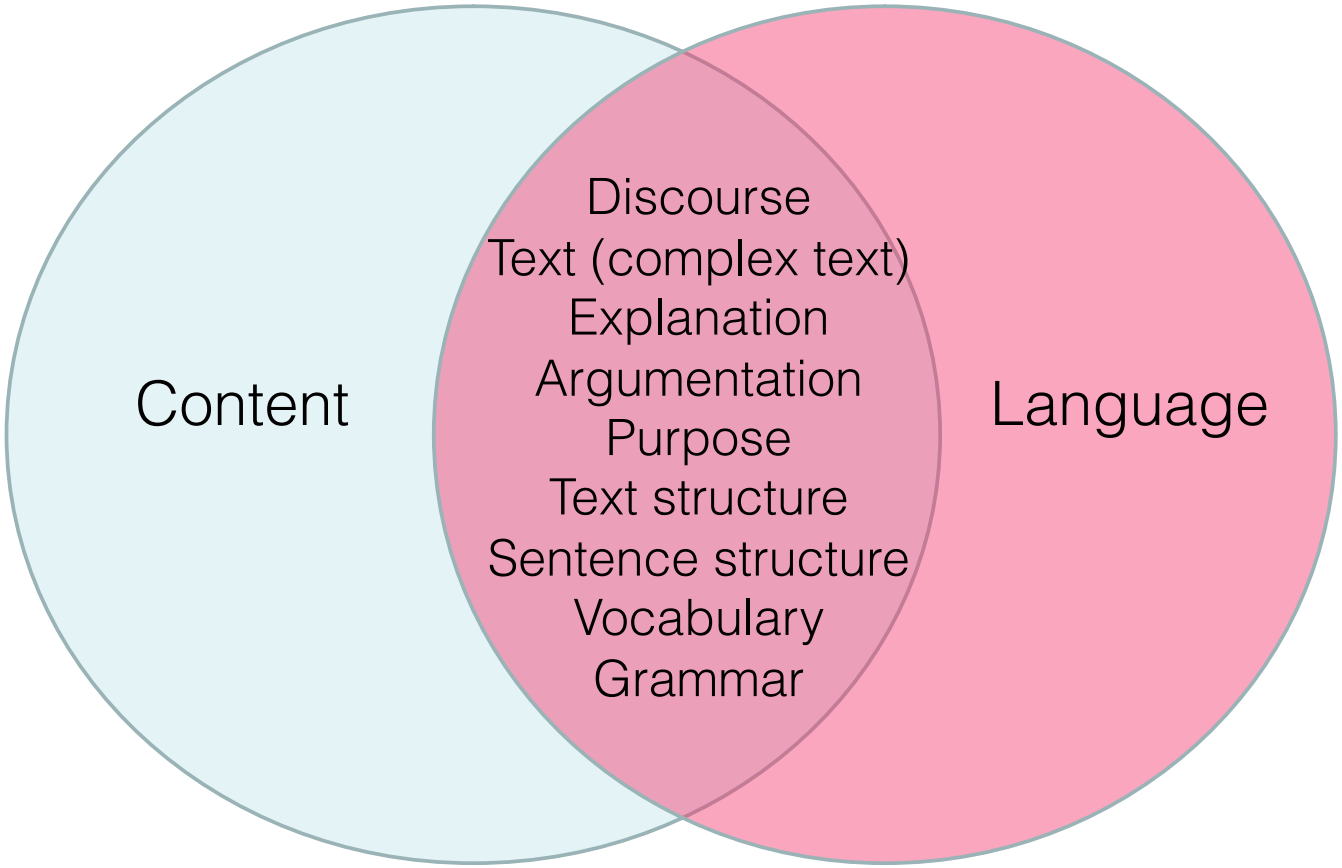
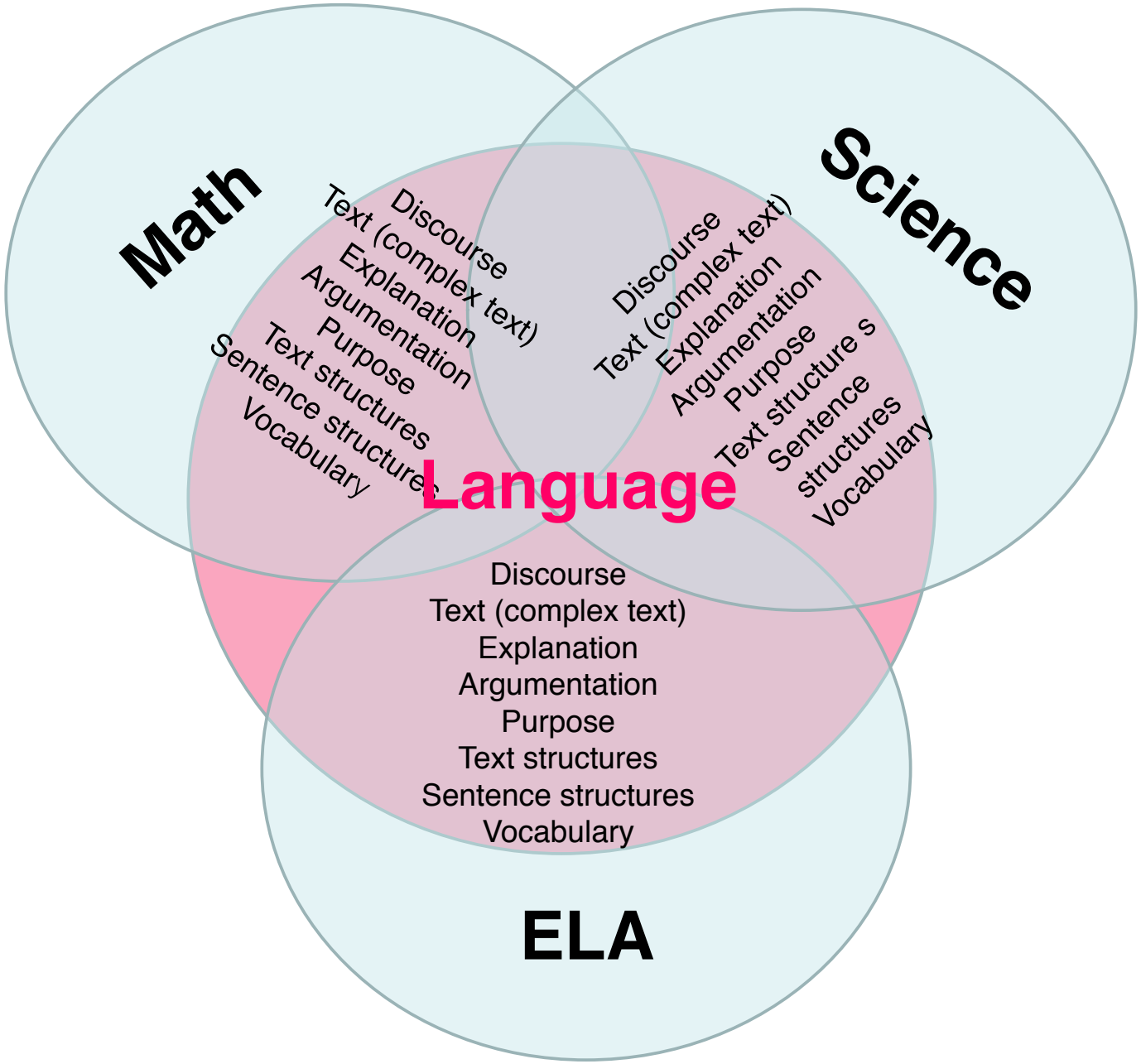
Old Paradigm



New Paradigm




Math
Science
ELA
Language
Discourse
Text (complex text)
Explanation
Argumentation
Purpose
Text structures
Sentence structures
Vocabulary
Discourse
Text (complex text)
Explanation
Argumentation
Purpose
Text structure s
Sentence structures
Vocabulary
Discourse
Text (complex text)
Explanation
Argumentation
Purpose
Text structures
Sentence structures
Vocabulary

Theme 3: Engineering

- **From an epistemological and historical perspective:**
  Recognize contributions of other cultures historically

- **From a pedagogical perspective:**
  By solving problems in local contexts, students gain knowledge of science content and engage in science in socially relevant and transformative ways

- **From a global perspective:**
  Innovation and creativity through engineering is particularly important for students who traditionally have not recognized science as relevant to their lives or future

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Theme 4: Crosscutting Concepts

- Explicit teaching of crosscutting concepts enables less privileged students to make connections among big ideas that cut across science disciplines
- This could offer opportunities for students who otherwise might not have such exposure and access

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NGSS Diversity and Equity Charges

Task 1. Bias Reviews of Standards

Task 2. Appendix D

Task 3. Seven Case Studies

Task 4. Diversity and Equity Topic in Appendices

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NGSS Diversity and Equity Team

- Okhee Lee, team leader
- Emily Miller, ESL and bilingual resource teacher
- Rita Januszyk, gifted and talented education
- Bernadine Okoro, alternative education
- Betsy O'Day, special education
- Netosh Jones, race
- Jennifer Gutierrez, poverty

NEXT GENERATION SCIENCE STANDARDS

Task 1: Bias Reviews (2 Rounds)

"Guidelines for Bias Reviews of NGSS Standards"

- **Diversity and Equity**
  - To avoid bias and stereotypes
  - To represent diverse groups of students
  - To use inclusive language
- **Consistency of Language**
  - To enhance clear and common understanding, especially scientific terms
- **Clarity of Language**
  - To avoid unnecessarily difficult language
  - To remove unnecessary and redundant words and phrases

NEXT GENERATION SCIENCE STANDARDS

Task 2: Appendix D

(1) NGSS Learning Opportunities and Demands for Diversity and Equity

(2) Effective Strategies in

- Science classroom
- School resources
- Home and community

(3) Context

- Demographics
- Science achievement
- Educational policy

NEXT GENERATION SCIENCE STANDARDS

Task 2: Appendix D

Four Accountability Groups

1. Economically disadvantaged students
2. Students from major racial and ethnic groups
3. Students with disabilities
4. Students with limited English proficiency

Three Additional Groups

5. Girls
6. Students in alternative education programs
7. Gifted and talented students

NEXT GENERATION SCIENCE STANDARDS

Task 3: Seven Case Studies

Each Case Study Includes:

(1) Vignette Highlighting:

- NGSS connections
- CCSS connections for ELA and math
- Classroom strategies

(2) Research-Based Classroom Strategies

(3) Context

- Demographics
- Science achievement
- Educational policy

NEXT GENERATION SCIENCE STANDARDS

NGSS and CCSS Connections

Economically Disadvantaged: **Grade 9 Physical Science**	• Developing Conceptual Models to Explain Chemical Processes
Racial and Ethnic Groups: **Grade 8 Life science**	• Constructing Explanations to Compare the Cycle of Matter and the Flow of Energy through Local Ecosystems
Disabilities: **Grade 6 Space Science**	• Using Models of Space Systems to Describe Patterns
English Language Learners: **Grade 2 Earth Science**	• Developing and Using Models to Represent Earth's Surface Systems
Girls: **Grade 3 Engineering**	• Defining Problems with Multiple Solutions within an Ecosystem
Alternative Education: **Grade 10 & 11 Physical Science**	• Constructing Explanations about Energy in Chemical Processes
Gifted and Talented: **Grade 4 Life Science**	• Constructing Arguments about the Interaction of Structure and Function in Plants and Animals

Vignette

Blending three dimensions with effective classroom strategies


Classroom Strategies
School Resources
Equitable Learning Opportunities
Home Connections
Community Connections

Demographic Groups	Student Engagement	Classroom Support Strategies	School Support Systems	Home and Community Connections
Economically Disadvantaged Students	students' sense of place	project-based learning	school resources and funding	students' funds of knowledge
Racial and Ethnic Groups	multimodal experiences	multiple representations; culturally relevant pedagogy	role models and mentors	community involvement; culturally relevant pedagogy
Students with Disabilities	accommodations and modifications	differentiated instruction; Universal Design for Learning; Response to Intervention	accommodations and modifications	
English Language Learners	discourse practices	language and literacy support	home language support	home culture connections
Girls	relevance; real-world application	curricular focus	school structure	relevance; real-world application
Students in Alternative Education	safe learning environment	individualized academic support	after-school opportunities; career & technology opportunities	family outreach
Gifted and Talented Students	strategic grouping; self–direction opportunities	fast pacing; challenge level		

English Language Learners and the Next Generation Science Standards

Vignette: Developing and Using Models to Represent Earth's Surface Systems

After sharing the parent interviews and hearing Mrs. Xiong's presentation, the class was convinced that soil was different in different places, but they wanted to be sure that this was true for soil from different places in their neighborhood, too. Ms. H. tried to center all her science investigations in culturally relevant contexts, in this case their neighborhood. (*This "place-based" strategy established connections between school science and the students' community and lives.*) ***Classroom Strategy***

Ms. H. encouraged students to gather physical evidence for their claim that "soil was different in different places." They decided that the best way to support their claim was to observe soil taken from different places near the school. (Practice: Planning and Carrying Out Investigations.) They used a topographical map and an aerial photo map of the neighborhood to determine soil sites that seemed different: a hill, the marsh, and the school yard. They noticed that the sites had different trees—deciduous trees, no trees, and coniferous trees—and different elevations. (DCI: K-2-ESS2.B: Earth's Systems.) It was at these sites that the students collected and investigated the soil, forming the basis for comparisons based on evidence and the soil profile diagrams each group constructed.

The following week, Ms. H. helped her students think in terms of patterns when exploring similarities and differences in the soil in the neighborhood. (CCC: Patterns.) The students observed the soil colors, texture, smell and infiltration, and collected data about the organisms in the soil. They learned a lot about patterns in soil composition. (DCI:PS1.A: Structure and Properties of Matter.) ***Blending of Three Dimensions***

Performance Expectations ***Bundling of PEs***

2. Earth's Surface Systems: Processes that Shape the Earth

2-ESS2-1

Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

2-ESS2-2

Develop a model to represent the shapes and kinds of land and bodies of water in an area.

Task 4: Diversity and Equity Theme in Appendices

- Front Matter
- Appendix C: College and Career Readiness
- Appendix D: All Standards, All Students *(of course)*
- Appendix F: Science and Engineering Practices
- Appendix G: Crosscutting Concepts
- Appendix H: Understanding the Scientific Enterprise: The Nature of Science
- Appendix I: Engineering Design
- Appendix J: Science, Technology, Society, and Environment

NEXT GENERATION SCIENCE STANDARDS

Career and College Ready

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