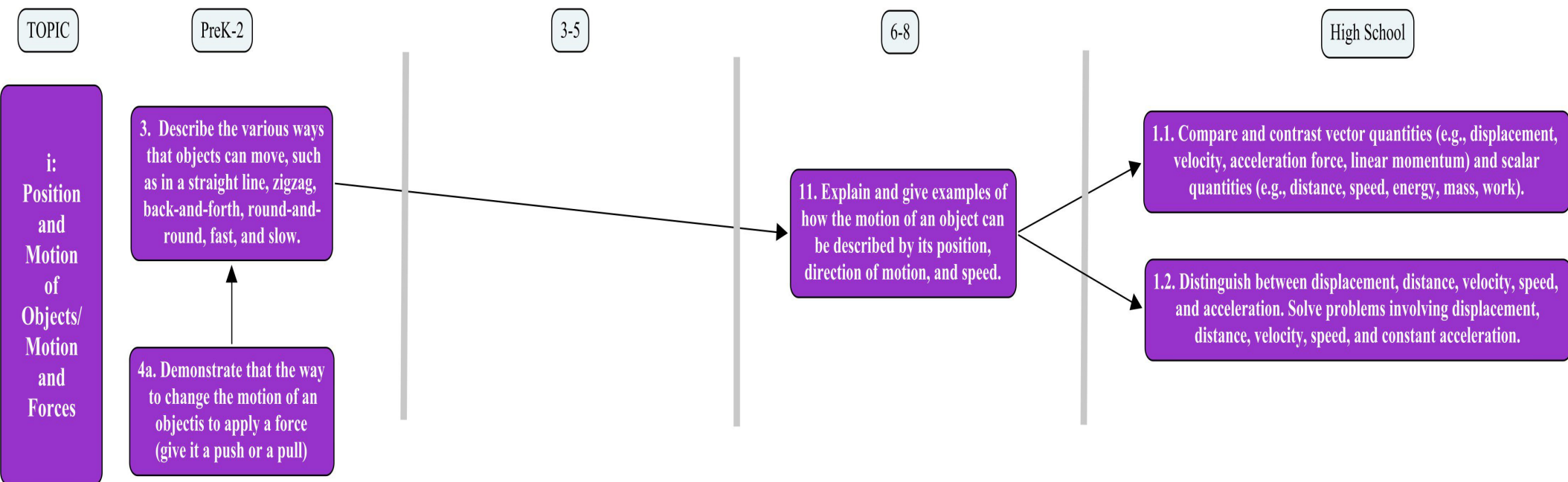


How do strand maps differ from concept maps?

- Quantity of conceptual content
- Meaning of linking arrows
- Linkage to additional digital resources

Portion of Physical Science Strand Map: Force and Motion Progression

Figure 1. Portion of the Physical Science strand map showing several *force and motion* standards (From *Strand Maps of the 2001/2006 Science and Technology/Engineering Standards* <http://www.doe.mass.edu/omste/maps/>)



Standard = numbered phrase in the MA STE Framework (color coded to the topic it is currently associated with)

5. Describe the hierarchical organization of multicellular organisms from cells to tissues to organs to systems to organisms.

A standard specifies what students should know and be able to do:

- Demonstrated knowledge *and* skills
- Assessable and/or measurable

Concept = a conceptual unit of understanding (may be a whole or partial standard)

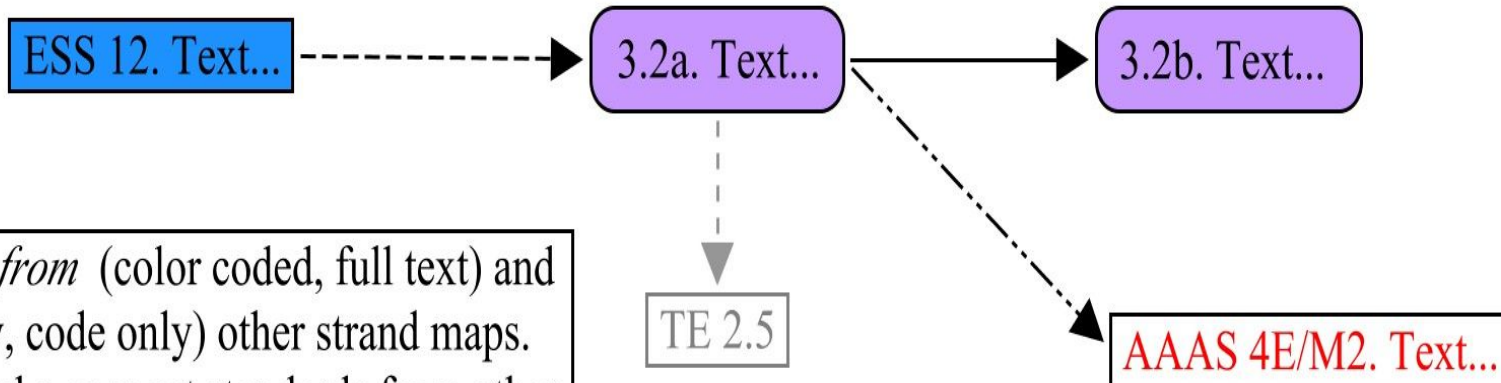
Some standards were split if they included multiple concepts or skills that stand on their own (but not always).

9a. Recognize plant behaviors, such as the way seedlings' stems grow toward light and their roots grow downward in response to gravity. (!?)

9b. Recognize that many plants and animals can survive harsh environments because of seasonal behaviors, e.g., in winter, some trees shed leaves, some animals hibernate, and other animals migrate. (!?)

Key to Strand Map

Original standards, color coded by topic.
Solid link connects standards within the strand map.



Standards *from* (color coded, full text) and *to* (gray, code only) other strand maps.
Dashed links connect standards from other strand maps.

Additional AAAS benchmark (not in standards).
Variable dashed link connects AAAS benchmarks.

Notation at the end of a standard indicate particular comments found on the corresponding notes pages. Ex: **(?!)** **(2)**

Assumptions Underlying the Strand Maps

Some assumptions were made in the creation of the maps that will assist in interpreting the meaning of the maps.

Assumption 1

Links show how standards contribute to one another

- Linking arrows = connections that are *necessary* for learning, NOT *possible* connections between concepts (In AAAS Atlas language: “one contributes to achieving the other”).
- An arrow *leaving* a standard implies that the concept contributes to learning the concept of the next/connected standard.
- These links are primarily based upon:
 - Wisdom of practice, professional judgment
 - Logic of the subject matter
 - Cognitive research specific to a particular idea
 - General principles of cognitive development: for ex: concrete before abstract; simple before complex

Assumption 2

The strand maps represent the current STE Framework

- Standards are always kept within the grade span and strand in which they currently are found in the Framework.
- The topic the standard is associated with may shift within the strand.
- Coloring designates the original topic (where the standard currently resides in the Framework).

Assumption 3

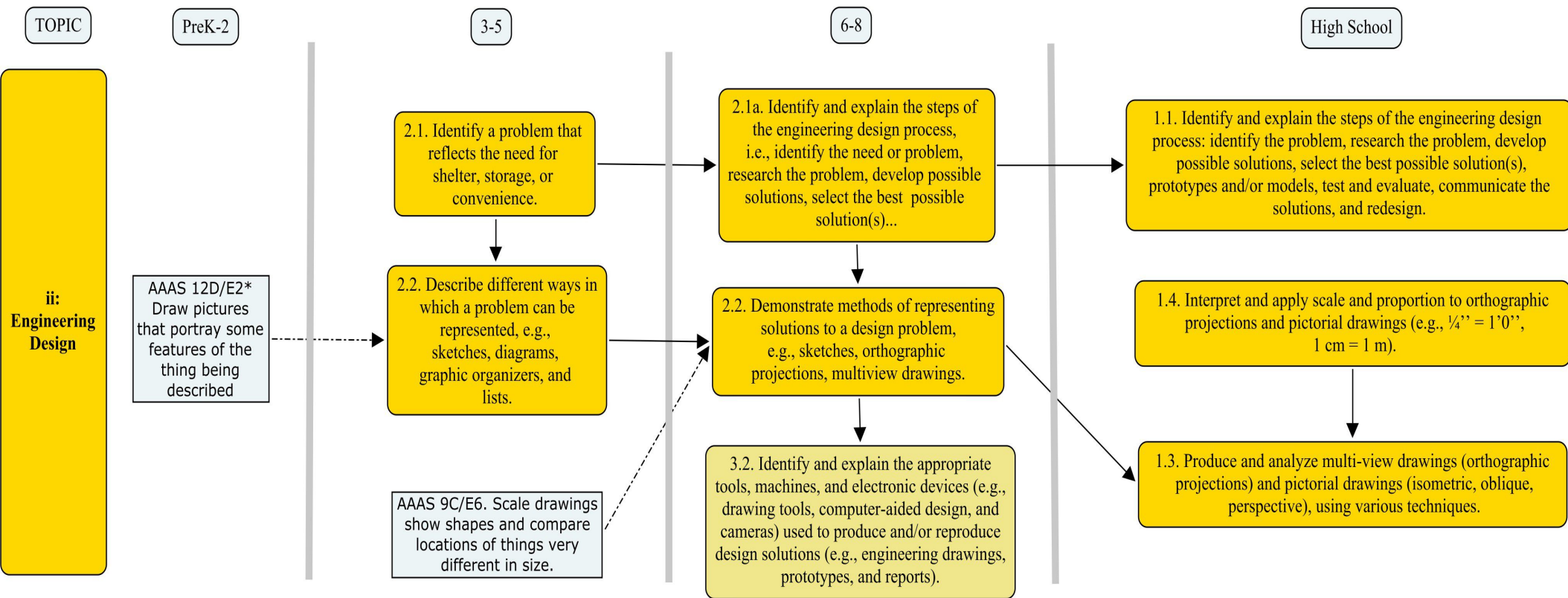
Simple is better

- Tried to have as few arrows as was necessary.
- The placement of standards (or concepts) is first by affiliation to a topic, and then placed to reduce any “spaghetti” effects.

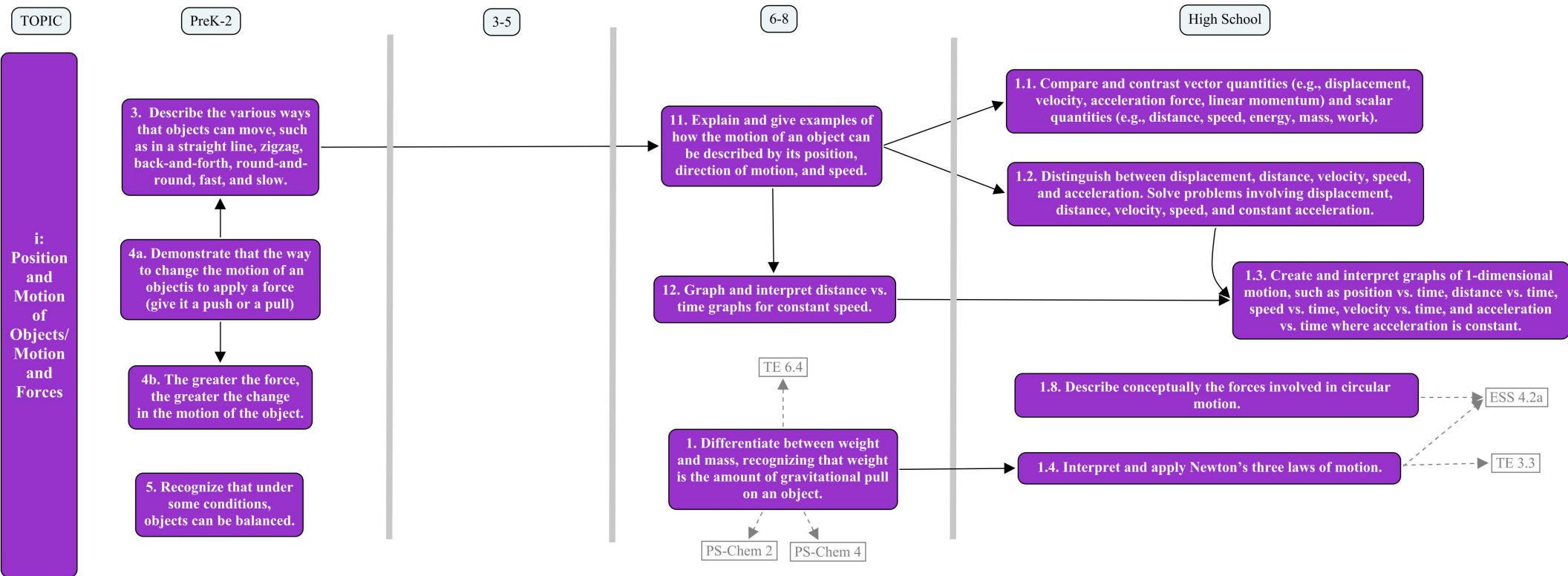
What patterns emerged from the Strand Maps?

- Patterns that would prove useful to the science curriculum review process: identification of unsupported standards
- Patterns that demonstrated aspects of Ausubelian Learning Theory

Missing Foundational Standards



Opportunity-to-Learn Gaps & Isolated Concepts



Diverging Standards

TOPIC

PreK-2

3-5

6-8

High School

iv:
Anatomy
and
Physiology

PS-Chem 6. Differentiate between an atom (the smallest unit of an element that maintains the characteristics of that element) and a molecule (the smallest unit of a compound that maintains the characteristics of that compound).

5. Describe the hierarchical organization of multicellular organisms from cells to tissues to organs to systems to organisms.

6a. Identify the general functions of the major systems of the human body (digestion, respiration, reproduction, circulation, excretion, protection from disease, and movement, control, and coordination).

4.1a. Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules.

4.3. Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide.

4.2a. Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes.

4.5a. Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscles, bones, cartilage, ligaments, tendons) works with other systems to support the body and allow for movement.

4.4a. Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication among different parts of the body and mediates the body's interactions with the environment.

4.6a. Recognize that the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father.

Converging & Crosslinking Standards

