As most of you would be aware, Project 2061 is a long-term initiative of AAAS to reform K-12 education nationwide so that all high-school graduates are science literate. Historically, Project 2061 was launched in 1985 when Halley’s comet last appeared (and takes its name from the average Halley’s period of 76 years). The director of Project 2061, James Rutherford (incidentally, also a Director of Harvard Project Physics), during his address in 1997 “Reflecting on Sputnik” articulated a need for reforms to focus on the attainment of long-term educational goals for all students.

Career development researchers such as Feller and Davies (1999, p. 121) also argue that school-to-career initiatives would provide some of the best educational strategies for all students. Several other researchers (Avent, 1988; Bandura, 1997; Dewey, 1933; Doty & Stanley, 1985; Harris, 1999; Herring, 1998; Rogers, 1942; Whitehead, 1929; Zunker, 1994) have observed that involving students sooner in their career development process helps to not only raise their awareness on the importance of self-reflection but also provides meaning to their present education. Bandura (1997) observed, “the choices people make during the formative periods of development shape the course of their lives.” (p. 422).

In their publication Benchmarks for science literacy, the Project 2061 team outline “statements of what all students should know or be able to do in science, and technology by the ends of grades 2, 5, 8, and 12. The grade demarcations suggest reasonable checkpoints for estimating student progress toward the science literacy goals” (1993, p. xi).

The researcher believes that the key to science literacy is student understanding of scientific concepts. Therefore, the proposed study deliberately excludes mathematics because the researcher would like to isolate and promote a qualitative understanding of science and technology, without losing students who might have mathematical difficulties. Using the Atlas of science literacy (2001), student difficulties with physics and science are identified.

A review of literature in physics education (Griffiths, 1997, Hestenes, 1998) reveals the amateurish state of physics teaching. The proposed study highlighting current trends in physics education research, will attempt instead to use technology for tracking students online as they achieve the science literacy benchmarks. Simon and associates (1992) observed, “finding the underlying bases of human choice behavior is difficult” (p. 41).

Educational researchers such as Kafai (1995) and Reiber (1996) observe that by combining technology with instructional games, students learn subject content effectively. It is ironical, as Reiber (1995) mentions that gaming, a basic component of human interaction, has received scant interest among instructional design researchers. This study therefore attempts to identify canons of students’ choices (which influence their goal setting, decision-making, and problem solving skills), within a virtual gaming environment, to inform further research, design and development of epistemic games that promote higher order thinking skills.
Of the 65 science literacy benchmarks outlined in BSL (1993), the proposed study attempts to focus on only 26 of these benchmarks in the BSL from K-8. They are:

1. **THE NATURE OF SCIENCE**  
   (*Colorado Model Science Content Standard 1*)  
   1A - The Scientific World View (*K-2; 3-5; 6-8*)  
   1B - Scientific Inquiry (*K-2; 3-5; 6-8*)  
   1C - The Scientific Enterprise (*K-2; 3-5; 6-8*)

2. **THE NATURE OF TECHNOLOGY**  
   (*Colorado Model Science Content Standard 5*)  
   3A - Technology and Science (*K-2; 3-5; 6-8*)  
   3B - Design and Systems (*K-2; 3-5; 6-8*)  
   3C - Issues in Technology (*K-2; 3-5; 6-8*)

3. **THE PHYSICAL SETTING**  
   (*Colorado Model Science Content Standard 2 - Physics*)  
   4B - The Earth (*K-2; 3-5; 6-8*)  
   4D - Structure of Matter (*K-2; 3-5; 6-8*)  
   4E - Energy Transformations (*K-2; 3-5; 6-8*)  
   4F - Motion (*K-2; 3-5; 6-8*)  
   4G - Forces of Nature (*K-2; 3-5; 6-8*)

4. **THE HUMAN ORGANISM**  
   (*Colorado Model Science Content Standard 5*)  
   6D - Learning (*K-2; 3-5; 6-8*)

5. **THE DESIGNED WORLD**  
   (*Colorado Model Science Content Standard 2 - Physics*)  
   8C - Energy Sources and Use (*K-2; 3-5; 6-8*)  
   8D - Communication (*K-2; 3-5; 6-8*)

6. **THE MATHEMATICAL WORLD**  
   (*Colorado Model Science Content Standard 1*)  
   9B - Symbolic Relationships (*K-2; 3-5; 6-8*)

7. **HISTORICAL PERSPECTIVES**  
   (*Colorado Model Science Content Standard 2 - Physics*)  
   10G - Splitting the Atom (*6-8*)  
   10J - Harnessing Power (*6-8*)
11. COMMON THEMES
   *(Colorado Model Science Content Standard 6)*

   11A - Systems (K-2; 3-5; 6-8)
   11B - Models (K-2; 3-5; 6-8)
   11C - Constancy and Change (K-2; 3-5; 6-8)
   11D - Scale (K-2; 3-5; 6-8)

12. HABITS AND MIND
   *(Colorado Model Science Content Standard 1)*

   12A - Values and Attitudes (K-2; 3-5; 6-8)
   12C - Manipulation and Observation (K-2; 3-5; 6-8)
   12D - Communication Skills (K-2; 3-5; 6-8)
   12E - Critical-Response Skills (K-2; 3-5; 6-8)

*Colorado Model Content Standards*

1. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
2. Physical Science: Students know and understand common properties, forms, and changes in matter and energy.
3. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
4. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

*In the matrices that follow, the words highlighted and italicized in bold print, show overlap between the Colorado Model Content Standards and the National Science Literacy Standards (Benchmarks).*
## Benchmark #1
THE NATURE OF SCIENCE

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>K-2 concepts that might be used to promote science literacy benchmarks</th>
<th>3-5 concepts that might be used to promote science literacy benchmarks</th>
<th>6-8 concepts that might be used to promote science literacy benchmarks</th>
<th>Some illustrative student difficulties identified through research (SOURCE: ASL, 2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A – The Scientific World View</td>
<td>Promote understanding of consistency in world view <strong>Explain inconsistency while investigating the world around</strong></td>
<td>Explore durability/susceptibility to change in scientific knowledge as new theories are developed</td>
<td>Upper elementary- and middle-school students appear to view experimentation as a method of simply trying things out to produce a desired outcome, instead of testing ideas/hypothesis.</td>
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<tr>
<td>1B – Scientific Inquiry</td>
<td>Use fun and exciting investigations to promote: observation, <strong>need for tools</strong>, accurate descriptions, <strong>explanations</strong>, and compare observations</td>
<td>Use interesting investigations to promote: group work, careful observation, recording of data, class presentations, openness, and evidence gathering</td>
<td>More systematic investigations to promote: <strong>written plan</strong>, control of variables, logical reasoning, collecting evidence, <strong>developing hypotheses</strong>, objectivity, and work of scientists</td>
<td></td>
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<tr>
<td>1C – The Scientific Enterprise</td>
<td>Team work, invent things, share and <strong>communicate findings</strong>, encourage curiosity and creativity, encourage reaching individual conclusions</td>
<td>Replicate and communicate findings clearly, <strong>use tables and graphs</strong>, include career information, scientific visits and talks, explain how science engages men and women of all ages and backgrounds</td>
<td>Promote science and science-related careers as real options, understand risks and benefits associated with scientific research, use computers productively and <strong>collaboratively</strong> to collect, store, compile, and analyze data, to share with investigators around the world</td>
<td>Students seem to have difficulty identifying important variables, leave alone control them. They tend to invoke personal experiences as evidence to justify hypothesis. They tend to look for or accept evidence that is consistent with their prior beliefs.</td>
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<td>Benchmark #4</td>
<td>THE PHYSICAL SETTING</td>
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<td>6-8 concepts that might be used to promote science literacy benchmarks (Columns 1 – 4, SOURCE: BSL, 1993)</td>
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<td></td>
<td>Some illustrative student difficulties identified through research (SOURCE: ASL, 2001)</td>
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<tr>
<th>4F – Motion</th>
<th>Student should be able to describe how objects might move in several different ways: straight, zigzag, curved paths, back and forth, and fast and slow. Pushing or pulling might <strong>change the movement</strong>. Music and sound are caused by vibrations.</th>
</tr>
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<td></td>
<td>Students should know that <strong>forces cause changes</strong> in speed or direction of motion/movement. They should identify the relation between strength of force and change in motion. They should also be able to relate this with the mass of an object. They should recognize how some objects move very fast and some very slow. They should use prisms to see how white light might produce a rainbow of colors. Students should appreciate that light is made up of a mixture of several different colors. They should understand how seeing and hearing depends on light and sound entering our eyes and ears. However, we can see and hear only within a limited range. Vibrations (such as sound, light, and earthquakes) move in different speeds in different materials. They should understand that an unbalanced force might change the motion of an object. Also when a force acts toward a single center, objects might curve and orbit around the center.</td>
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<td>Students tend to think of force as a property of an object rather than a relation or interaction between objects. They believe that objects at rest have no force acting on them. They tend to confuse inertia with friction, when objects accelerate. Some research suggests that students can appreciate that forces always need not act in the direction of motion.</td>
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REFERENCES


