Views of Nature of Science (form B)*

VNOS (B)

* Reference:

Abd-El-Khalick, F., Bell, R. L., & Lederman, N. G. (1998). The nature of science and instructional practice: Making the unnatural natural. *Science Education, 82*(4), 417-437.

Bell, R., Blair, L., Crawford, B., & Lederman, N. G. (in press). Just do it? The impact of a science apprenticeship program on high school students' understandings of the nature of science and scientific inquiry. *Journal of Research in Science Teaching*.

Bell, R. L., Lederman, N. G., & Abd-El-Khalick, F. (2000). Developing and acting upon one's conception of the nature of science: A follow-up study. *Journal of Research in Science Teaching, 37,* 563-581.

Bell, R., & Lederman, N. G. (in press). Understandings of the nature of science and decision making on science and technology based issues. *Science Education*.

VNOS (B)

Name: _____

Date: / /

Instructions: Answer the following questions, using the back of the page if you need more space. Please note that there are no “right” or “wrong” answers to these questions. I am simply interested in your views of a number of issues about science.

1. After scientists have developed a theory (e.g., atomic theory, kinetic molecular theory, cell theory), does the theory ever change? If you believe that scientific theories do not change, explain why and defend your answer with examples. If you believe that theories do change: (a) Explain why. (b) Explain why we bother to teach and learn scientific theories. Defend your answer with examples.

2. Science textbooks often represent the atom as a central nucleus composed of positively charged particles (protons) and neutral particles (neutrons) with negatively charged particles (electrons) orbiting the nucleus. How certain are scientists about the structure of the atom? What specific evidence do you think scientists used to determine the structure of the atom?

3. Is there a difference between a scientific theory and a scientific law? Give an example to illustrate your answer.

4. How are science and art similar? How are they different?

5. Scientists perform experiments/investigations when trying to solve problems. Other than in the stage of planning and design, do scientists use their creativity and imagination in the process of performing these experiments/investigations? Please explain your answer and provide appropriate examples.

6. In the recent past, astronomers differed greatly in their predictions of the ultimate fate of the universe. Some astronomers believed that the universe is expanding while others believed that it is shrinking, still others believed that the universe is in a static state without any expansion or shrinkage. How were these different conclusions possible if the astronomers were all looking at the same experiments and data?

Item Description

1. After scientists have developed a theory (e.g., atomic theory, kinetic molecular theory, cell theory), does the theory ever change? If you believe that scientific theories do not change, explain why and defend your answer with examples. If you believe that theories do change: (a) Explain why. (b) Explain why we bother to teach and learn scientific theories. Defend your answer with examples.

Note: Parentheticals are not part of the questionnaire.

(This question aims to assess understandings of the tentative nature of scientific claims and why these claims change. It is common for respondents to attribute such change solely to the accumulation of new facts and technologies, rather than the inferential nature of scientific theories and/or paradigm shifts. The question also aims to assess respondents' understandings of the role of theories in science as well as the theory-laden nature of scientific observations.)

2. Science textbooks often represent the atom as a central nucleus composed of positively charged particles (protons) and neutral particles (neutrons) with negatively charged particles (electrons) orbiting the nucleus. How certain are scientists about the structure of the atom? What specific evidence do you think scientists used to determine the structure of the atom?

(This question aims to assess understandings of the role of human inference and creativity in science, the role of models in science, and the notion that scientific models are not copies of reality.)

3. Is there a difference between a scientific theory and a scientific law? Give an example to illustrate your answer.

(This question aims to get at a common misconception about the relationship between the products of science. Many respondents believe in a hierarchical relationship between the two whereby theories become laws if and when enough evidence has been accumulated in their favor. Additionally, respondents express many ideas related to their understandings of the nature of science and science process as they attempt to delineate the difference between theories and laws.)

4. How are science and art similar? How are they different?

(This question aims to assess understandings of the role of creativity and imagination in science, the necessity of empirical evidence in generating scientific knowledge, and the cultural and social embeddedness of science.)

5. Scientists perform experiments/investigations when trying to solve problems. Other than in the stage of planning and design, do scientists use their creativity and imagination in the process of performing these experiments/investigations? Please explain your answer and provide appropriate examples.

(This question aims to assess respondents' understandings of the role of human creativity and imagination in science. While respondents generally recognize that experimental design involves creativity, they rarely say that creativity is used in data analysis in the sense that scientists are, for instance, "creating" patterns rather than "discovering" them.)

6. In the recent past, astronomers differed greatly in their predictions of the ultimate fate of the universe. Some astronomers believed that the universe is expanding while others believed that it is shrinking, still others believed that the universe is in a static state without any expansion or shrinkage. How were these different conclusions possible if the astronomers were all looking at the same experiments and data?

(By posing a scientific controversy and stressing the fact that scientists are using the same data but coming up with differing explanations, this question invites respondents to think about factors that affect scientists' work. The factors range from scientists' personal preferences and biases to differing theoretical commitments to social and cultural factors.)