

## Scoring Rubric

Students'/Teachers' views of NOS aspects are categorized into naïve, transitional, or informed based on the following criteria:

Naïve: Student's/Teacher's response is not consistent with any part of NOS aspect.

Transitional: Student's/Teacher's response is consistent with some, but not all, parts of NOS aspect.

Informed: Student's/Teacher's response is consistent and addresses ALL parts of NOS aspect.

## NOS Aspects

### 1. Distinction between observations and inferences

Observations are descriptive statements about natural phenomena that are “directly” accessible to the senses (or extensions of the senses). By contrast, inferences are statements about phenomena that are not “directly” accessible to the senses.

### 2. Empirical

Scientific knowledge is, at least partially, based on and/or derived from observations of the natural world

### 3. Creative and imaginative

Scientific knowledge involves human imagination and creativity. Science involves the *invention* of explanations and this requires a great deal of creativity by scientists.

### 4. Subjective

Scientific knowledge is subjective. Scientists’ theoretical commitments, beliefs, previous knowledge, training, experiences, and expectations actually influence their work. Scientists’ observations (and investigations) are always motivated and guided by, and acquire meaning in reference to questions or problems. These questions or problems, in turn, are derived from within certain theoretical perspectives (theory-laden).

### 5. Social and culture embeddedness

Science as a human enterprise is practiced in the context of a larger culture and its practitioners (scientists) are the product of that culture. Science, it follows, affects and is affected by the various elements and intellectual spheres of the culture in which it is embedded. These elements include, but are not limited to, social fabric, power structures, politics, socioeconomic factors, philosophy, and religion.

### 6. Tentative

Scientific knowledge is never absolute or certain. This knowledge, including “facts,” theories, and laws, is tentative and subject to change. Scientific claims change as new evidence, made possible through advances in *theory* and technology, is brought to bear on existing theories or laws, or as old evidence is reinterpreted in the light of new theoretical advances or shifts in the directions of established research programs

### 7. Distinction between scientific laws and theories

Individuals often hold a simplistic, hierarchical view of the relationship between theories and laws whereby theories become laws depending on the availability of supporting evidence. However, theories and laws are different kinds of knowledge and one can not develop or be transformed into the other. Laws are *statements or descriptions of the relationships* among observable phenomena. Theories, by contrast, *are inferred explanations* for observable phenomena.

## Corresponding VNOS D+ Questions and Targeted Aspects of the Nature of Science

When rating your students' views on each of the seven targeted aspects of the nature of science as naïve, transitional or informed, you can use the information below to determine which questions probes which targeted aspect of the nature of science.

VNOS D+ Question	Targeted Aspect of the Nature of Science
1	More of an ice-breaker than anything else. However, in describing science they often bring up issues related to certainty of the knowledge (tentativeness) and objectivity.
2	More specific than #1, and here is where information about creativity, empirical basis, and subjectivity often arise
3	Targets tentativeness, but often yields some data on observation, inference, and subjectivity
4a	Targets observation and inference
4b	Targets tentativeness and inference
4c	Targets inference and subjectivity
4d	Targets empirical basis
5	Targets tentativeness, and observation/inference
6	Targets observation and inference
7	Targets creativity and subjectivity
8	Targets theory and law
9	Targets tentativeness
10	Targets social and cultural embeddedness