PhysPort Implementation Guide: Views of Nature of Science Questionnaire (VNOS)

Version D+

PhysPort
Supporting physics teaching with research-based resources

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Implementation

Purpose of the VNOS

To elucidate students' views about several aspects of the nature of science.

Course Level: What kinds of courses is it appropriate for?

Intro college, High school, and Middle school

Content: What does it test?

Beliefs / Attitudes (nature of science, theories and laws, tentativeness, creativity, objectivity, subjectivity, social and cultural influences)

Timing: How long should I give students to take it?

60 minutes

Example Questions

Sample question from the VNOS:

Scientists produce scientific knowledge. Do you think this knowledge may change in the future? Explain your answer and give an example.

In order to predict the weather, weather persons collect different types of information. Often they produce computer models of different weather patterns. (a) Do you think weather persons are certain (sure) about the computer models of the weather patterns? (b) Why or Why not?

Access: Where do I get the test?

Download the test from physport at www.physport.org/assessments/VNOS.

Versions and Variations: Which version of the test should I use?

The latest version of the VNOS, released in 2010, is version D+ and was developed by Norman G. Lederman and Judith Lederman. Version D+ is a modification of version C (1998, developed by Norman G. Lederman, Randy Bell, Fouad Abd-El-Khalick, and Renee Schwartz). Version D+ is shorter and easier for students to complete in 60 minutes. Version C is a modification and expansion of version B (1990, developed by Norman G. Lederman and Randy Bell). Version B added item 3, modified items 1, 2, 5, and 7, and added five new items. Version B is a revision of version A (1990, developed by Norman G. Lederman). There is also a version E of the VNOS that was created for elementary students (developed by Judith Lederman and Eun Kyung Ko).

Administering: How do I give the test?

- If you are interested in learning how your students' nature of science ideas change as a result of your course, give it as both a pre- and post-test.
  - Give the pre-test at the beginning of the term.
  - Give the post-test at the end of the term.
- Use the whole test, with the original wording and question order. This makes comparisons with other classes meaningful.
- Make the test required, and give credit for completing the test (but not correctness). This ensures maximum participation from your students.
- Tell your students there are no right or wrong answers to any item and that the intention is to elicit their views on some issues related to nature of science. Tell them that correctness will not affect their grades (only participation). This helps alleviate student anxiety.
- For more details, read the **PhysPort Guides** on implementation:
  - **PhysPort Expert Recommendation on Best Practices for Administering Belief Surveys** (www.physport.org/expert/AdministeringBeliefSurveys/)

Scoring: How do I calculate my students' scores?

- Download the scoring rubric from PhysPort (www.physport.org/key/VNOS)
- Since the VNOS is an open-ended survey, it is important to interview a subset of your students about their answers. Once you are confident you are accurately interpreting their responses, you can compare the written answers to the scoring rubric, and categorize students' views about seven aspects of the nature of science as naïve, transitional or informed.
- The assessment developers routinely conduct training sessions with users of the VNOS in order to insure correct scoring and reliability in scoring because they find that it is difficult to correctly use the VNOS without the training. Contact the developers, Dr. Norman Lederman (ledermann@iit.edu) or Dr. Judith Lederman (ledermanj@iit.edu) for more information on these training sessions.
- For more information on interviewing students about their answers and scoring the VNOS, see below
- See the **PhysPort Expert Recommendation on Best Practices for Administering Belief Surveys** for instructions on calculating shift and effect size (www.physport.org/expert/AdministeringBeliefSurveys/)

Follow-up Interviews with Students

After administration of the VNOS, a reasonable sample of respondents should be individually interviewed. During those interviews, respondents are provided their questionnaires and asked to explain and justify their responses. Follow-up questions could be used to clarify ambiguities, assess meanings that respondents ascribe to key terms and phrases, and explore respondents' lines of thinking. For researchers using the VNOS for the first time, the developers recommend interviewing all or a large majority of respondents. With repeated use, researchers should develop expertise in interpreting VNOS responses. Such expertise becomes evident when researchers obtain high degrees of correspondence between their inferences regarding respondents' NOS views as derived from VNOS written responses and the views elucidated by those respondents during interviews. At this point, researchers could interview subsamples of respondents. The developers find that interviewing 15–20% of participants is sufficient to gauge subtleties of meaning associated with a certain group of respondents or a certain context. Interviewees could be chosen randomly or purposively depending on the purpose of administering the VNOS.

Rating Students' Written VNOS Answers

Once you feel certain about your ability to correctly interpret students' written VNOS responses, you rate each students' views of seven target aspects of the nature of science as naive, transitional or informed using the VNOS scoring rubric, which expands on each of these seven aspects. These target aspects are: Distinction between observations and inferences, empirical, creative and imaginative, subjective, cultural and social embededdness, tentative, and distinction between scientific laws and theories.

The analysis of responses to VNOS items does not assume a restrictive one-to-one correspondence between a question on the questionnaire and a target NOS aspect. Several nature of science aspects can be targeted by one question, and several questions can assess students' views on one aspect of the nature of science.

Low inference is desired throughout the analysis. This is not to say that respondents' answers should be taken literally. Indeed, data from follow-up interviews often suggest alternative ways of interpreting responses, which on initial examination seem strongly to suggest certain nature of science views. Nonetheless, care should be exercised not to load respondents' words and phrases with high-inference meanings or impose on respondents' views consistent structures unless such inferences are supported with interview data. Indeed, in many cases the developers found that respondents' views were fluid, fragmented, and compartmentalized.

Clusters: Does this test include clusters of questions by topic?

There are no clusters of questions on the VNOS-D+.

Typical Results: What scores are usually achieved?

Typical results for the VNOS (from Lederman 2002):

Table 1
Comparison of expert and novice group responses to the VNOS-B

NOS Aspect	Expert Group ($N=9$)		Novice Group ($N=9$)	
	n^a	%	n^a	%
Empirical nature of scientific knowledge				
Observations used to make scientific claims	9	(100%)	8	(89%)
Science does not rely solely on empirical evidence	9	(100%)	3	(33%)
Supports rather than proves scientific claims	9	(100%)	3	(33%)
Inference and theoretical entities in science				
Inferential nature of atomic models	9	(100%)	6	(67%)
Nature of scientific theories				
Theories change due to new evidence	9	(100%)	7	(78%)
Theories change due to new ways of looking at existing evidence	8	(89%)	4	(44%)
Explanatory power of scientific theories	8	(89%)	1	(11%)
Theories are well-substantiated	9	(100%)	0	(0%)
Theories provide a framework for current knowledge and future investigations	7	(78%)	1	(11%)
Scientific theories vs. laws				
Nonhierarchical relationship	9	(100%)	0	(0%)
Laws may change	9	(100%)	1	(11%)
Creativity in science				
Creativity permeates scientific processes	9	(100%)	4	(44%)
No single scientific method	9	(100%)	0	(0%)
Subjectivity in science (theory-ladenness)				
Differences in data interpretation	9	(100%)	5	(56%)
Science is necessarily a mixture of objective and subjective components	9	(78%)	2	(22%)
Social and cultural influences				
Science as a culture within itself	8	(89%)	0	(0%)
Peer review limits subjectivity	3	(33%)	1	(11%)
Society as an influence on science	2	(22%)	2	(22%)
Overall	169	(89%)	64	(33%)

[a]Number of participants in each group with informed views of the target NOS aspect.

Instructors should not expect students to score well on the VNOS unless there is an explicit attempt to teach ideas around the nature of science.

Interpretation: How do I interpret my students' score in light of typical results?

For each student, you can get a sense of which target aspect of the nature of science they need help developing by looking at your rating (naive, transitional, informed) for each aspect. You can also look at trends in ratings for each target aspect for all of your students to get a sense of how your teaching either helped developed certain target aspects or on which target aspects you might concentrate on helping your students improve in future courses.

Resources

Where can I learn more about this test?

N. Lederman, F. Abd-El-Khalick, R. Bell, and R. Schwartz, Views of Nature of Science Questionnaire: Toward Valid and Meaningful Assessment of Learners' Conceptions of Nature of Science, J. Res. Sci. Teaching **39** (6), 497 (2002).

Translations: Where can I find translations of this test in other languages?

We don't have any translations of this assessment yet.

If you know of a translation that we don't have yet, or if you would like to translate this assessment, please contact us!

Background

Similar Tests

The VNOS and VOSE cover similar topics around the nature of science. The main difference between them is the format. The VNOS is open-ended while the VOSE asks students to agree/disagree with different options. Another difference between the VOSE and VNOS, is that in addition to asking about students' philosophical beliefs about science, the VOSE asks students to agree/disagree with statements about how to teach the nature of science, which the VNOS does not.

Research: What research has been done to create and validate the test?

Research Validation: Silver

This is the second highest level of research validation, corresponding to at least 5 of the validation categories below.

- [x] Based on research into **student thinking**
- [x] Studied using **student interviews**
- [x] Studied using **expert review**
- [ ] Studied using **appropriate statistical analysis**
- [x] Research conducted **at multiple institutions**
- [x] Research conducted **by multiple research groups**
- [x] **Peer-reviewed publication**

Research Overview

The open-ended questions on the VNOS were created by the developers and an initial version (A) was tested in student interviews to ensure that students interpreted the questions in the way intended. The questions were revised to create version B and tested in another set of student interviews. Version B was tested with experts and novices and the developers found that experts scored much higher than novices, as expected. Version B was further modified to create version C, which then underwent expert review. Version D+ is shorter version that provides the same data as VNOS-C, which is very long. This version was developed from focus groups of teachers in Project ICAN, which was using VNOS-C. The VNOS was administered to undergraduates and graduates, and pre-service teachers. The VNOS has been given to over 2000 students and results are published in over peer-reviewed 9 publications.

Developer: Who developed this test?

Norman G. Lederman, Fouad Abd-El-Khalick, Randy L. Bell, Renee S. Schwartz, Judith Lederman, Eun Kyung Ko

References

- N. Lederman, F. Abd-El-Khalick, R. Bell, and R. Schwartz, Views of Nature of Science Questionnaire: Toward Valid and Meaningful Assessment of Learners' Conceptions of Nature of Science, J. Res. Sci. Teaching **39** (6), 497 (2002).