Implementation Guide by Sam McKagan and Adrian Madsen

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Purpose of the VOSE
To be a valid, meaningful, and practical instrument for creating in-depth profiles of the views of college students or adults, including pre- and in-service teachers, about the nature of science, and NOS instruction.

Course Level: What kinds of courses is it appropriate for?
Upper-level, Intermediate, Intro college, and High school

Content: What does it assess?
Beliefs / Attitudes (nature of science, theories and laws, tentativeness, creativity, objectivity, subjectivity, scientific method, teaching the nature of science)

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

Example Questions
Sample question from the VOSE:

When two different theories arise to explain the same phenomenon (e.g., fossils of dinosaurs), will scientists accept the two theories at the same time?

A. Yes, because scientists still cannot objectively tell which one is better; therefore, they will accept both tentatively.
B. Yes, because the two theories may provide explanations from different perspectives, there is no right or wrong.
C. No, because scientists tend to accept the theory they are more familiar with.
D. No, because scientists tend to accept the simpler theories and avoid complex theories.
E. No, the academic status of each theory proposer will influence scientists’ acceptance of the theory.
F. No, scientists tend to accept new theories which deviate less from the contemporary core scientific theory.
G. No, scientists use intuition to make judgments.
H. No, because there is only one truth, scientists will not accept any theory before distinguishing which is best.

Access: Where do I get the assessment?
Download the assessment from physport at www.physport.org/assessments/VOSE.

Versions and Variations: Which version of the assessment should I use?
The latest version of the VOSE, released in 2006, is version 1. Several pilot versions were tested starting in 2000 before creating this version.

Administrating: How do I give the assessment?
- 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 before you cover relevant course material.
  ◆ 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?**

The VOSE has 15 statements, each of which has 3-9 possible responses for students to agree or disagree with. Students may agree with more than one of the responses. There are no right or wrong answers, but each statement corresponds to a particular "position" on one or more subtopics of nature of science (NOS). The developer has created an extensive list of coding categories to "create and in-depth profile of a [student's] NOS views and educational ideas." For the coding categories, see below.

**Coding categories for VOSE** (from Chen 2006)

**Table 1: NOS issues, philosophical positions, and item number tested by VOSE**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Position</th>
<th>Itema</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tentativeness</td>
<td>Revolutionary</td>
<td>4A</td>
</tr>
<tr>
<td></td>
<td>Cumulativeb</td>
<td>4B</td>
</tr>
<tr>
<td></td>
<td>Evolutionaryb</td>
<td>4C</td>
</tr>
<tr>
<td>Nature of observations</td>
<td>Theory-laden</td>
<td>8A,8B,8E</td>
</tr>
<tr>
<td></td>
<td>Theory-independent</td>
<td>8C,8D</td>
</tr>
<tr>
<td>Scientific methods</td>
<td>The universal scientific methodb</td>
<td>9A,9B,9F</td>
</tr>
<tr>
<td></td>
<td>Diverse methods</td>
<td>9C,9D,9E</td>
</tr>
<tr>
<td>Theories and laws</td>
<td>Epistemology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discoveredb</td>
<td>5A,5B (Theory) 6A,6B (Law)</td>
</tr>
<tr>
<td></td>
<td>Invented</td>
<td>5D,5E,5F (Theory) 6D,6E (Law)</td>
</tr>
<tr>
<td></td>
<td>Discovered or invented</td>
<td>5C (Theory) 6C (Law)</td>
</tr>
<tr>
<td></td>
<td>Comparison</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laws being more certainb</td>
<td>7A,7B</td>
</tr>
<tr>
<td></td>
<td>Different types of ideas</td>
<td>7C,7D</td>
</tr>
<tr>
<td>Use of imagination</td>
<td>Yes</td>
<td>3A,3B</td>
</tr>
<tr>
<td></td>
<td>Nob</td>
<td>3C,3D,3E</td>
</tr>
<tr>
<td>Validation of scientific knowledge</td>
<td>Empirical evidence</td>
<td>1A,1H</td>
</tr>
<tr>
<td></td>
<td>Paradigm</td>
<td>1C,1F</td>
</tr>
<tr>
<td></td>
<td>Parsimony</td>
<td>1D</td>
</tr>
<tr>
<td></td>
<td>Authority</td>
<td>1E</td>
</tr>
<tr>
<td></td>
<td>Intuition</td>
<td>1G</td>
</tr>
<tr>
<td>Subjectivity and objectivity</td>
<td>Subjectivity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parsimony</td>
<td>1D (Actual)</td>
</tr>
<tr>
<td></td>
<td>Authority</td>
<td>1E (Actual)</td>
</tr>
<tr>
<td></td>
<td>Paradigm</td>
<td>1C,1F,8A,8B (Actual)</td>
</tr>
<tr>
<td></td>
<td>Personal factors</td>
<td>1G,8A (Actual) 15A,15D,15H (Ought)</td>
</tr>
<tr>
<td></td>
<td>Socio-cultural influence</td>
<td>2A,2B (Actual) 15B,15C (Ought)</td>
</tr>
<tr>
<td></td>
<td>Imagination</td>
<td>3A,3B (Actual)</td>
</tr>
</tbody>
</table>
Methodology | 9D (Actual)
Neutral | 1B (Actual)
Objectivity
No influence of socio-culture | 2C,2D (Actual) 15F (Ought)
Use no imagination | 3C,3E (Actual)
Based on experimental facts | 5B,6B,8D (Actual)
No influence of personal beliefs | 8C (Actual) 15E,15I (Ought)
Methodology | 8E,9A,9B (Actual)
Overall | 1A,1H (Actual) 15G (Ought)

Notes:
aThe numerical number indicates the question, while the letter represents the response for that question.
bThe corresponding items were scored in reverse to calculate the means of the issues.

Table 2: Attitudes toward teaching the NOS issues tested by VOSE

<table>
<thead>
<tr>
<th>Topic</th>
<th>Attitude</th>
<th>Item\textsuperscript{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tentativeness</td>
<td>Teaching the tentativeness of scientific knowledge</td>
<td>12A,12B</td>
</tr>
<tr>
<td></td>
<td>Avoid teaching the tentativeness of scientific knowledge\textsuperscript{b}</td>
<td>12C,12D,12E</td>
</tr>
<tr>
<td>Nature of observations</td>
<td>Training students to make objective observations\textsuperscript{b}</td>
<td>11A,11B,11C</td>
</tr>
<tr>
<td></td>
<td>Revealing the theory-laden nature of observations</td>
<td>11D,11E</td>
</tr>
<tr>
<td>Scientific methods</td>
<td>Teaching the universal scientific method\textsuperscript{b}</td>
<td>10A,10B,10C, 10D,10E,10F</td>
</tr>
<tr>
<td></td>
<td>Encouraging different methods</td>
<td>10G,10H,10I</td>
</tr>
<tr>
<td>Theories and laws</td>
<td>Teaching the relationship between theories and laws</td>
<td>13A,13B</td>
</tr>
<tr>
<td></td>
<td>Avoid teaching the relationship\textsuperscript{b}</td>
<td>13C,13D</td>
</tr>
<tr>
<td>Subjectivity and objectivity</td>
<td>Teaching subjectivity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Personal factors</td>
<td>14A,14D</td>
</tr>
<tr>
<td></td>
<td>Socio-cultural influences</td>
<td>14B,14C</td>
</tr>
<tr>
<td></td>
<td>Emphasizing objectivity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No influence of personal beliefs</td>
<td>14E</td>
</tr>
<tr>
<td></td>
<td>No influence of socio-culture</td>
<td>14F</td>
</tr>
<tr>
<td></td>
<td>Value free in science courses</td>
<td>14G</td>
</tr>
</tbody>
</table>

Notes:
aThe numerical number indicates the question, while the letter represents the response for that question.
bThe corresponding items were scored in reverse to calculate the means of the issues.

Calculating a numerical score:

Burton 2013 developed a numerical system for calculating a numerical score for each issue or topic, by assigning a number between 0 and 4 to a student's response for each item listed under that issue or topic in Table 1 or 2 above and calculating the average. (Strongly Disagree = 0, Disagree = 1, Uncertain = 2, Agree = 3, Strongly Agree = 4).

Clusters: Does this assessment include clusters of questions by topic?
The clusters on the VOSE are listed in Tables 1 and 2 above.

Typical Results: What scores are usually achieved?
Typical scores on the VOSE from (Burton 2013)
Interpretation: How do I interpret my students’ scores in light of typical results?

Review your students’ responses:

One way to use the VOSE is to read through your students' responses to get a qualitative feel for how they are thinking about the responses. You can use Tables 1 and 2 above to see which NOS positions each item represents.

Calculate a numerical score:

You can use Burton's numerical scheme, described above, to calculate a numerical score for each issue or position, and compare to Burton's results in the Typical Results section.

Resources

Where can I learn more about this assessment?


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

You can download translations of this assessment in the following languages from PhysPort:

- Chinese translated by Sufen Chen
- English

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 Assessments

The VOSE and the VNOS 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 assessment?

Research Validation: Silver

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

- Based on research into student thinking
- Studied using student interviews
- Studied using expert review
- Research conducted at multiple institutions
- Research conducted by multiple research groups
- Peer-reviewed publication

Research Overview

The VOSE Likert-scale questions were developed based on questions from the VOSTS. An initial version of the VOSE was given to 14 American and 10 Taiwanese pre-service teachers, who were all interviewed about their responses. The survey questions were substantially revised, and the “draft VOSE” was created. It was given to 120 biology students in Taiwan, and further revised to ensure variation across respondents and to reduce the rate of neutral responses. The VOSE underwent expert review and further student interviews and was again revised. The VOSE was written and tested in Chinese and translated into English. The VOSE has been used with over 300 students in multiple majors at two Taiwanese universities and results published in two journal publications.

Developer: Who developed this assessment?

Sufen Chen

References

- E. Peters Burton, Student work products as a teaching tool for nature of science pedagogical knowledge: A professional development project with in-service secondary science teachers, Teaching Teacher Education 29 (1), 156 (2012).