Empirical Validation of a Learning Progression
(Using the BEAR Assessment System)

Jinnie Choi, Yong-Sang Lee, & Karen Draney, University of California, Berkeley

Abstract

Over the past several years, we have been working with the Environmental Literacy group at Michigan State University (see Mohan et. al in this symposium) on the development of a learning progression for the Carbon Cycle. In this poster, we will discuss our process of empirically validating this learning progression. The Michigan State group has collected assessment data from elementary, middle, and high school students to better understand how students explain the role of carbon in biogeochemical processes. Like other learning progressions, we used assessment data to develop potential upper and lower anchors for a carbon cycle learning progression and focused our analysis on identifying intermediate stages between those two anchor points. We apply item response modeling techniques and graphical methods to investigate the levels of the learning progression and the average performance levels of students at various grade levels.

Overview of the Carbon Cycle Project

- A part of the NSF-funded Environmental Science Literacy Project that aims to integrate Environmental Science Literacy into contemporary K-12 curriculum
- Expected products are 1) research-based learning progressions, 2) assessment resources, and 3) teaching resources

The BEAR Assessment System (BAS)

- Four building blocks (or principles) that are aligned with National Research Council (2001) assessment triangle
  - [NRC] An iterative approach that not only enables inference about a construct, but also guides to the building of a sound assessment system to measure that construct
  - [BAS] Four building blocks (or principles) that are aligned with National Research Council (2001) assessment triangle

Research Questions

- What are the empirical procedures to validate learning progressions for the Carbon Cycle project?
- What does the empirical evidence look like?
- What criteria can we get to test?

Process of Validation

Construct Map

- Building the Theory of Learning Progression
  - Current Learning Progression Framework for the Carbon Cycle
  - Progress Variables
  - Environmental Science Literacy Project

Empirical Evidence

Measurement Models

- Evaluating Models for Analysis & Inference
  - Item Response Modeling technique allows you to make inference about not only a construct, but also the characteristics of both the students and the assessment items, and the relationship between them
  - A variety of models to choose from, based on the data and the research questions
  - The simplest Rasch model

Item Response Model Estimates

- Person ability (\( \theta \)) estimates tells you the location of each person on the learning progression
- Item difficulty (\( b_j \)) estimates tells you whether your items tapping the levels of achievement as you planned
- Reliability coefficients tells you how reliable your estimation of person abilities is
- Other things that you can get from more complex models:
  - Item-person interaction effect (DIF) on the responses
  - Effect of the characteristics of items on the responses
  - Effect of the characteristics of persons on the responses
  - Multidimensional structure of person abilities related to the assessment

Fit Statistics

- Model fit
  - Model fit tells you how well the model explains each item
  - Person fit tells you how well the model explains each person

Graphical Results

- Wright Map helps you to compare the distributions of persons and items on the same scale

More Evidence...

Scores

<table>
<thead>
<tr>
<th>Characteristic of Response</th>
<th>Example Responses</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>High processing of energy, especially from photosynthesis and respiration.</td>
<td>photosynthesis, respiration</td>
<td>5</td>
</tr>
<tr>
<td>Low processing of energy, especially from respiration and photosynthesis.</td>
<td>respiration, photosynthesis</td>
<td>4</td>
</tr>
<tr>
<td>Mid processing of energy, especially from combustion and respiration.</td>
<td>combustion, respiration</td>
<td>3</td>
</tr>
</tbody>
</table>

More to come...

More Information

- Environmental Literacy website
- http://edrs.educ.msu.edu/EnvironmentalLit/index.htm
- Berkeley Evaluation and Assessment Research (BEAR) Center
- http://bearcenter.berkeley.edu