

The Ocean Literacy Principles

Understanding the Impact of This Educator-Scientist Collaboration

on Public Understanding of Science

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ABSTRACT

Ocean Literacy Index through the use of Rasch modeling.

Data: Responses were collected from an interstate sample of 232 participants through an online link. Four sections knowledge, ocean ecology-related behaviors, ocean-related attitudes, and exposure to ocean concepts (as a moderating variable).

Methods: The Rasch model was used to generate a unidimensional measure of each construct: knowledge, behaviors, attitudes and exposure. Each section was initially examined for overall Rasch model fit, reliability, and differential item functioning (DIF) were examined using ConQuest. Inter-dimensional correlations were also examined.

Objective: The current set of analyses involved validating the **Results:** While a substantial number of items were rejected from the knowledge scale, the resulting four item sets showed relatively good model fit and no substantial evidence of DIF. The attitudes scale lacked sufficiently difficult items to measured four theoretically distinct constructs: ocean science correspond to the relatively high scoring sample. Correlations revealed a strong relationship between attitudes and behavior scales, but only moderate relationship between knowledge and these two constructs.

> Conclusions: Recognizing the limitations imposed by the demographics of the current sample, a larger sample size will contribute to more definitive results. With this being said, there is no current evidence to suggest that "Ocean Literacy" is comprised of three related sub-constructs (i.e., knowledge, attitudes, and behaviors). An alterative theory is suggested that could also be explored in future iterations.

INTRODUCTION

- There is traditionally little emphasis on ocean science topics COSEE—CA researchers have developed a survey that in K-12 classrooms. At the same time, the economic, legislative and health-related issues pertaining to the ocean have become increasingly evident.
- Educator-scientist collaborations led by the Center for Ocean Sciences Education Excellence—California (COSEE—CA) led to the development of the Ocean Literacy Principles and other related materials. The Ocean Literacy Principles are:
- 1. "The Earth has one big ocean with many features."
- 2. "The ocean and life in the ocean shape the features of the Earth."
- 3. "The ocean is a major influence on weather and climate.'
- 4. "The ocean makes the Earth habitable."
- "The ocean supports a great diversity of life and ecosystems."
- 6. "The ocean and humans are inextricably interconnected."
- 7. "The ocean is largely unexplored."

- measures understanding and attitudes about the ocean and the role that ocean sciences play in supporting understanding of Earth systems. A measure of ocean literacy, or the understanding of the mutual impact between humans and the ocean, is necessary to properly assess where awareness of ocean concepts is lacking and for potential interventions.
- The Survey of Ocean Literacy (OLS) is theoretically a measure of:
 - 1) Understanding of the seven Ocean Literacy Principles (factual knowledge)
- 2) Ability to communicate and make informed decisions regarding the ocean and its resources (behaviors)
- Additionally, ocean-related attitudes were included in the index as another indictor of ocean literacy as it has been shown to be highly related to environmental behaviors.
- Another set of items pertaining to a participant's exposure to ocean-related concepts was added as a potential moderating variable in subsequent analyses.

METHODS

- Our current definition assumes that the latent trait of ocean literacy is contributing to ocean-related knowledge, attitudes and behaviors (see Figure 1). The exposure construct underwent similar validation procedures, but was considered a moderating variable.
- The Rasch Model (Rasch, 1960):

$$\Pr\left(X_{ip} = 1\right) = \frac{e^{(\theta_p - \delta_i)}}{1 + e^{(\theta_p - \delta_i)}}$$

 δ_i = "difficulty" of item i

 θ_p = "latent ability" of participant p in the sample.

- Each construct was examined individually by applying the Rasch model using Master's (1982) Partial Credit Model (a generalization of the Rasch Model) through ConQuest (Wu, Adams, & Wilson, 1998).
- Scaling properties that were examined include differential item functioning (DIF), model fit (INFIT and OUTFIT statistics), person-separation reliability, and step disordering (for polytomous items).
- The knowledge, attitudes, and behaviors were then fit into a larger multidimensional model to determine how related the three dimensions the hypothetical model are as an indicator of the "Ocean Literacy" construct.
- The *knowledge* construct was comprised of 73 dichotomously scored items distributed across three forms (to reduce

- participant burden). Twenty of these items were the same across all three forms.
- The behaviors, attitudes, and exposure constructs were comprised of 11, 8 and 4 Likert-style items, respectively. These items were consistent across all three forms.
- The current iteration collected a total of 232 participants.
- A large percent of the sample was either female (72.8%) or of Caucasian ethnicity (80.6%). This sampling situation (combined with use of multiple survey forms) prevented examinations of differential item function (DIF) using these demographic characteristics.
- The median age of participants was 39.5. The median miles to the nearest ocean from the respondent's provided ZIP code was 6.0. The top half and lower half of both of these indicators were used during examinations of DIF.

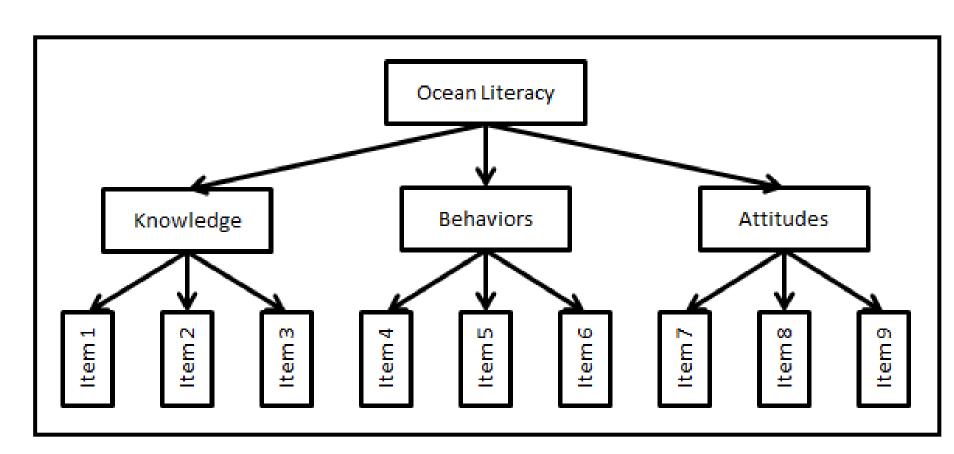


Figure 1: Current Model

RESULTS

- Of the 73 knowledge items, 38 were eliminated from the analysis due to poor model fit (exceeding the 0.75-1.33 boundary for the weighted mean-square fit; exceeding ±3.0 in the weighted t-statistic) or excessive DIF (i.e., > 1 logit difference in difficulty between the reference and focal groups using the age and distance demographics indicators).
- Weighted t Range | Reliability (EAP) WMNSQ Range Knowledge -2.5 to 2.5 0.78 to 1.22 0.861 -2.1 to 2.1 Behaviors 0.78 to 1.19 0.792 Attitudes 0.87 to 1.27 -1.0 to 2.3 0.623 -2.0 to 1.5 0.83 to 1.19 Exposure

Table 1: Fit and Reliability Statistics

RESULTS (CONT.)

- In comparison, only a single item was removed from the attitudes item set, and none were removed from the behaviors and exposure sections using the same conventions. The resulting scales showed no evidence of substantial violations to the Rasch assumptions (see Table 1).
- There was no evidence of step disordering for scales using polytomous items (i.e., behaviors, attitudes, and exposure) (see Figure 2). Item/person correspondence was satisfactory—and behavior sections were much lower (≈ 0.35). for all constructs except for attitudes, where the participants, as a whole, showed high proficiency. Thus, the current item set was not difficult enough for most of the participants. Item/person correspondence for the knowledge scale could also be improved with some more difficult items.
- Person-separation reliability was good for the attitudes and behaviors sections (> 0.75) (see Table 1). Reliability was acceptable but lower for the knowledge and exposure sections (≈0.65).
- The correlation between the attitudes and behavior dimensions was relatively strong (≈0.65) (see Table 2; lower half). Correlations between knowledge and both attitudes

	Knowledge	Behaviors	Attitudes
Knowledge	-	0.311	0.701
Behaviors	0.384	-	1.664
Attitudes	0.305	0.646	-

Table 2: Correlations between Constructs

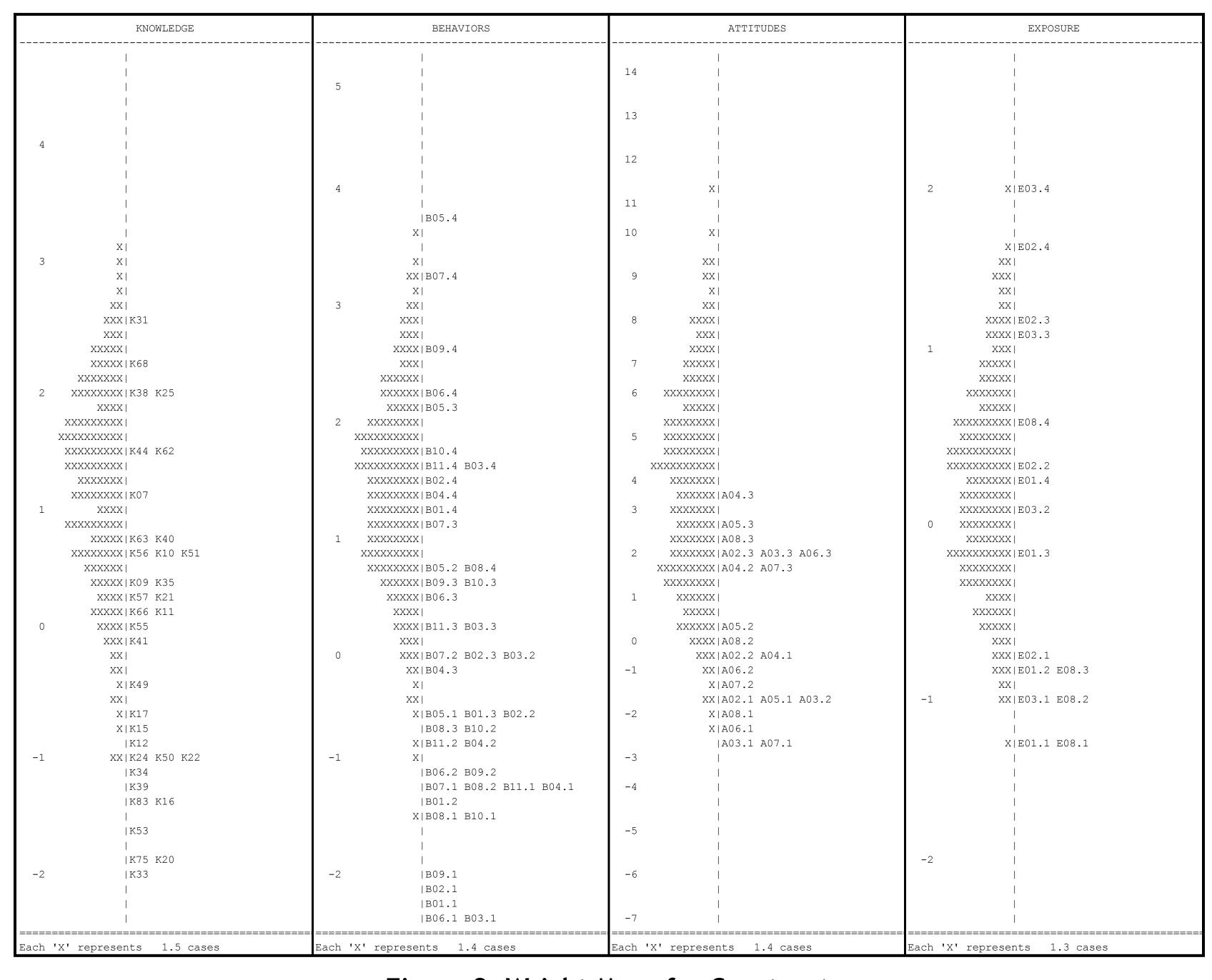


Figure 2: Wright Maps for Constructs

DISCUSSION

- A strong relationship between attitudes and behaviors was evident, as compared to the weak relationship between knowledge and both of these constructs. These results do not support the current (simple undimensional) model.
- However, these results may be due to poor functioning in each of the scales. The attitudes scale, in particular, exhibited unsatisfactory item/person correspondence.
- For future iterations, a larger sample with a more even distribution of gender and ethnicity is needed before a full examination of DIF can proceed. Further, more stringent tests of undimensionality (e.g., modified parallel analysis, principal components analysis of Rasch residuals) and DIF (e.g., anchor item methods) may be necessary to determine if the scales are sufficiently meeting Rasch model assumptions.
- An alternative model can be proposed using Ajzen &

Fishbein's *Theory of Reasoned Action* (1980) (see Figure 3). Testing of fit to this model will require the measurement of four forms of knowledge (declarative, procedural, effectiveness, and social), and behavior intention (a theoretical precursor to actual ecological behavior).

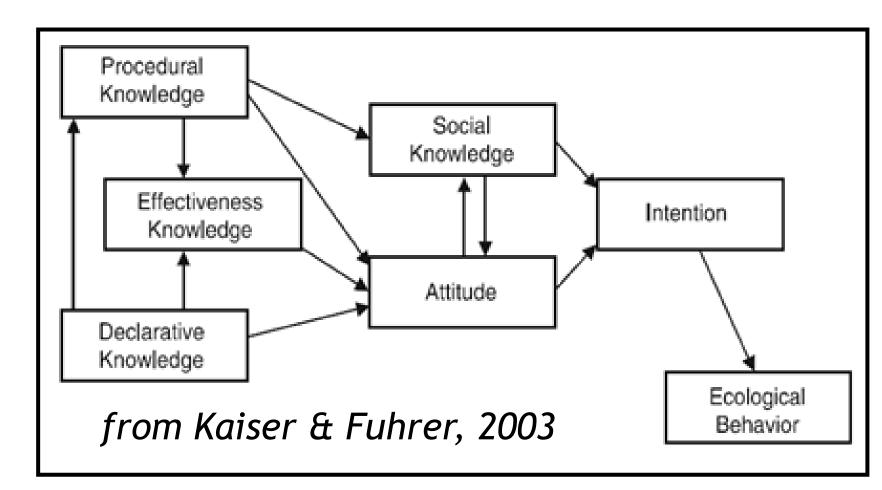


Figure 3: Theory of Reasoned Action

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