

Validation of an instrument measuring student complex causal assumptions

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Abstract

In this study, we present the validation evidence of a survey designed to assess student complex causal assumptions. We found that student responses could be explained by a two level measurement model, with responses to the complex causal domains of action at a distance, change over time, and non-obvious causes loading on a higher order factor, as well as a construct of agent-based causality. Reliability measures of the assessment when given before the instrument were adequate ($\alpha=0.71$), and students showed expected gains in the measures after using a multi-user virtual environment ($d=0.47$, $p<.001$).

EcoXPT Overview

EcoXPT is a NSF-funded continuation of the IES-funded EcoMUVE multi-user virtual environment. In the EcoMUVE, students worked together make observations and collect data in an effort to solve an ecosystems science related mystery (Metcalf, et al., 2011). In EcoXPT, students can also conduct experiments in order to better understand various causal mechanisms at play in the ecosystem .



Figure 1: The EcoXPT enclosures

For example, the enclosures in Figure 1 allow students to vary specific conditions in aquatic habitats, and to observe changes over time as compared to control conditions. A blended assessment protocol has been developed to gauge changes in student attitude, content knowledge, and causal understanding as they use the EcoXPT (Thompson, et al., 2016).

Causal Assessment of Understanding in Systems & Ecosystems (CAUSE)

One specific dimension is student understanding of the importance of various complex causal attributes of systems. In past studies, open-ended assessments have been iteratively coded to measure this domain (e.g., Grotzer et al., 2013). These open-ended prompts were recoded as Likert-type items (scale: 1-5) assessing the degree to which students believe it is important to attend to specific causal attributes in an ecosystem when solving a mystery about dead frogs. Face and content validity were established by expert reviewers. Results of assessments of construct validity follow.

	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree
It is important to look for clues at the edge of the pond.	<input type="radio"/>				
It's a bad idea to only focus on the things we can see.	<input type="radio"/>				
It is important to search for clues far away from the edge of the pond.	<input type="radio"/>				
Looking for clues far away from the edge of the pond is a waste of time.	<input type="radio"/>				
We need to focus on the day that we found the dead frogs.	<input type="radio"/>				
It's a bad idea to only look for clues from the day we found the dead frogs.	<input type="radio"/>				

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Results

Table 1. Reliability measures of pre-assessments across three validation studies of the CAUSE

Study 1	Study 2	Study 3
0.61	0.70	0.71

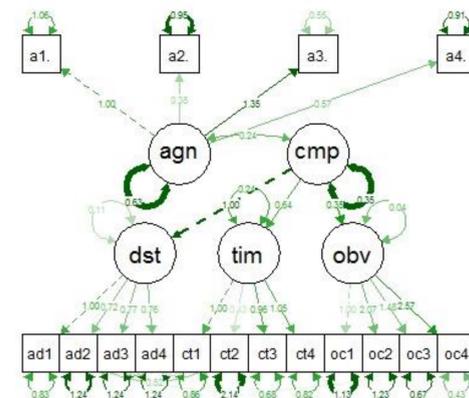


Figure 2. Confirmatory Factor Analysis of the reduced pre-assessment ($n=178$) ($\chi^2(38)=102.632$, $p=.303$; CFA=0.982; RMSEA=.020(0.000-0.045), $p=0.979$; SRMR=.063)

Change in Complex Causal Belief

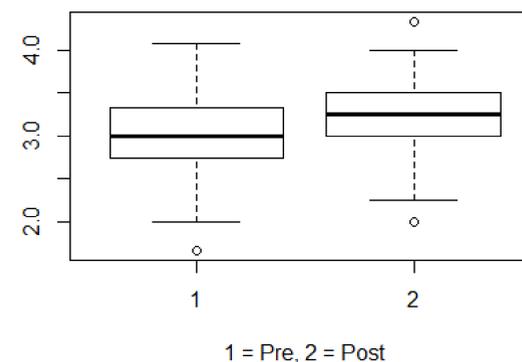


Figure 3. Average pre ($m=3.03(0.43)$) and post ($m=3.24(0.43)$) reduced survey scores ($n=144$)

$$\Delta=0.21^{***} (d=0.47)$$

Conclusions

Evidence suggests that the **CAUSE** instrument measures dimensions of middle-school student understanding of the importance of identifying complex causal attributes when tasked with solving an ecosystem-related mystery. Future research should explore the relationship between this measure and student content knowledge and affective state along important measures such as self-efficacy.

Works Cited

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