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Locating a Valid Instrument

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Should I Find an Instrument or Develop One of My Own?

- Finding an Instrument
 - What if one doesn't exist?
 - What if the instrument doesn't really match my project?
- Developing an Instrument
 - Time Consuming
 - Expensive
 - What happens if after all my work, the instrument is not valid?
- Options
 - Multiple measures
 - Mixed methods
 - Triangulation of results

Validity

Traditional Definition

Does the instrument measure what it claims to measure?

Updated Definition

When collecting data through the instrument, are the inferences researchers make defensible?

(Fraenkel, 2015)



Reliability: Consistency

An instrument cannot be *valid* unless it is *reliable*.

Types of Validity

Content

Criterion-referenced

- Predictive
- Concurrent

Construct

- Discriminant
- Convergent

Content Validity



Specialists in the content measured by the instrument are asked to judge the appropriateness of the items on the instrument.

Content Validity

Consider...

- *Do items cover the breadth of the content area?*
- *Are items in a format that is appropriate for those using the instrument?*

A test that is intended to measure the quality of science instruction in fifth grade should cover material taught in the fifth grade science course in a manner appropriate for fifth graders.

A national science test might not be a valid measure of *local* science instruction, although it might be a valid measure of *national* science standards (Siegel, 2016).



<http://www.computerhope.com>



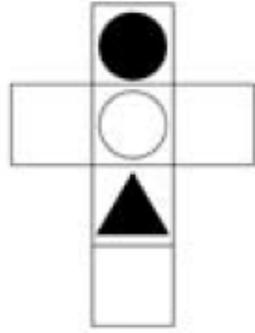
Establishing Content Validity

TIMSS Instrument : Trends in International Mathematics and Science Study (International Association for the Evaluation of Educational Achievement (IEA), 2015)

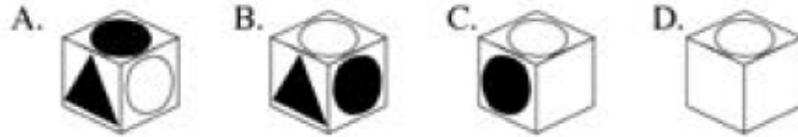
- Four experts reviewed the TIMSS instruments to determine which, if any items are related to a unit utilizing digital fabrication.
- Ten items were identified consistently. Those items are now considered a “subscale” of the TIMSS instrument
- A unit utilizing digital and 2D fabrication has been taught to different student four times. Students who are taught the unit consistently perform higher on those 10 items when compared to a control group.

TIMSS Example

Cube from folded 2-dimensional net



Which of these cubes could be made by folding the figure above?



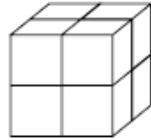
Item Number: B11

TIMSS Example

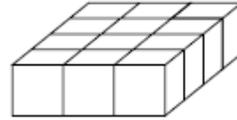
Volumes of stacks of blocks

All the small blocks are the same size. Which stack of blocks has a different volume from the others?

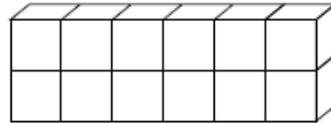
(A)



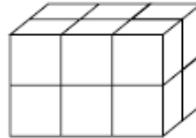
(B)



(C)



(D)



Item Number: M012013

Criterion-Referenced Validity



Criterion-related evidence is collected by comparing the instrument with some future or current criteria. The purpose of an instrument dictates whether predictive or concurrent validity is warranted.

Types of Criterion Validity



Predictive Validity

If an instrument is purported to measure some future performance, the instrument must be compared with the behavior that it predicts. Predictive validity would be important for a screening test for 5-year-olds that is purported to predict success in kindergarten.

Concurrent Validity

Concurrent validity compares scores on an instrument with current performance on another measure. Concurrent validity for a science test could be investigated by correlating scores for the test with scores from another established science test that covers the same content.

Construct Validity



The degree to which an instrument measures an intended psychological construct or non-observable trait (intelligence, creativity, etc) .

Types of Construct Validity



Discriminant Validity

An instrument does not correlate significantly with variables from which it should differ.

Convergent Validity

An instrument correlates highly with other variables with which it should theoretically correlate (Siegel, 2016).

HELP!!!!!!!!!!

Two of the teachers in my study did not administer the pretest.

What can I do???????



Good research design gone bad...

Retrospective Analysis

10. Think back to before you completed the Solenoid Kit. How would you rate your knowledge about the following things:

	I didn't really know much about this topic.	I knew a little about this topic.	I knew a fair amount about this topic.	I knew a lot about this topic.
Your understanding of magnetism (specifically polarity, attraction, and repulsion)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your understanding of magnetic fields	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your knowledge of conductivity (including insulators and conductors)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to explain voltage, current and resistance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How compasses work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
What electromagnetism is	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The similarities and differences between magnets and electromagnets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How voltage affects the interactions between magnets and	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Retrospective Analysis

11. Now that you have completed the solenoid unit, how would you rate your knowledge:

	I didn't really know much about this topic.	I knew a little about this topic.	I knew a fair amount about this topic.	I knew a lot about this topic.
Your understanding of magnetism (specifically polarity, attraction, and repulsion)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your understanding of magnetic fields	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your knowledge of conductivity (including insulators and conductors)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to explain voltage, current and resistance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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The similarities and differences between magnets and electromagnets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How voltage affects the interactions between magnets and electromagnets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Using Qualitative Data to Establish Content Validity

(Bull, 2016)

3. Figure 1. Wire disconnected from a battery, over a compass

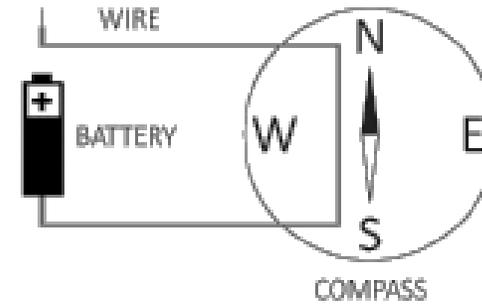
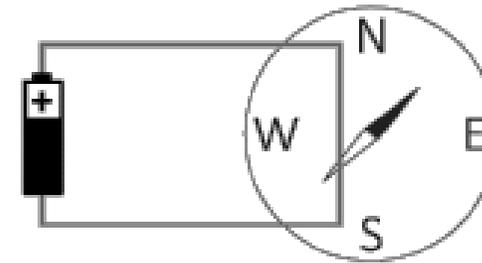


Figure 2. Wire connected to a battery, next to a compass



What is the best explanation of why the compass needle moved?

- The battery becomes magnetic when the circuit is closed.
- Electric current flowing through the closed circuit creates a magnetic field.
- The closed circuit creates electrical energy.
- The compass needs the battery connected to be turned on.

4. Explain as best you can why the compass needle moved.



Conclusions/Hopes for the Future

- Instrumentation is important.
- Sharing data across projects can help to establish the worth of an instrument.
- Large data sets can provide valuable information about STEM learning.

References

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