Test Item Writing from the Perspective of Measurement Theory

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Published Standardised Tests that I have helped develop…

- Hattie, J. A. C., Brown, G. T. L., Keegan, P. J., et al. (2004, December). *Assessment Tools for Teaching and Learning (asTTle) Version 4, 2005: Manual.* Wellington, NZ: University of Auckland/ Ministry of Education/ Learning Media. [Mx, Rdg, Wrg Levels 2-6]
- Hattie, J. A. C., Brown, G. T. L., Keegan, P. J., et al. (2003, December). *Assessment Tools for Teaching and Learning (asTTle) Manual* (Version 3 2004). Wellington: Learning Media. [Mx Level 2-4, Rdg & Wrg Levels 2-6]
- Hattie, J. A., Brown, G. T. L., & Keegan, P. J. (2002). *Assessment Tools for Teaching and Learning (asTTle) manual: Version 2, 2003* (V2 edn.). Wellington, NZ: Learning Media. [Mx, Rdg, Wrg Levels 2-4]
- Hattie, J. A., Brown, G. T. L., & Keegan, P. J. (2002). *Assessment Tools for Teaching and Learning (asTTle) manual: English literacy 2002* (V1 edn.). Wellington, NZ: Learning Media. [Rdg & Wrg Levels 2-4]
- Croft, C., Dunn, K., & Brown, G. T. L. (2001). *Essential Skills Assessment: Information Skills. Manual.* Wellington: NZCER. [Grades 5-10]

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Assessment Defined

Appropriate and accurate interpretations and decisions based on appropriate collection of valid information about valued content (a domain of interest)

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Domain

- A theoretically defined topic or construct of interest
  - Curriculum defined
  - Classroom experience informed
- Domains are structured bodies of knowledge
  - Taxonomic structures that indicate entry points, key points, sub-fields and relationships
- May be debate as to what is in the domain depending on related fields such as
  - Teaching theory
- Hence, it can be difficult to agree upon

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Defining a test

- A sample of tasks, questions, items drawn from a domain of interest intended to elicit information about learner skill, knowledge, understanding about that domain
- In order to make inferences about:
  - Improving learning/teaching;
  - Evaluating students;
  - Evaluating schools/teachers;
  - Evaluating curriculum.

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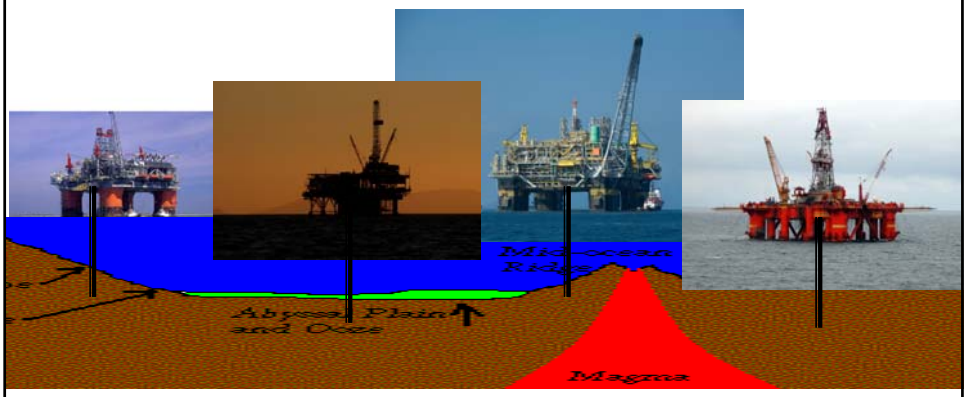
Sampling a domain



Test=Sample

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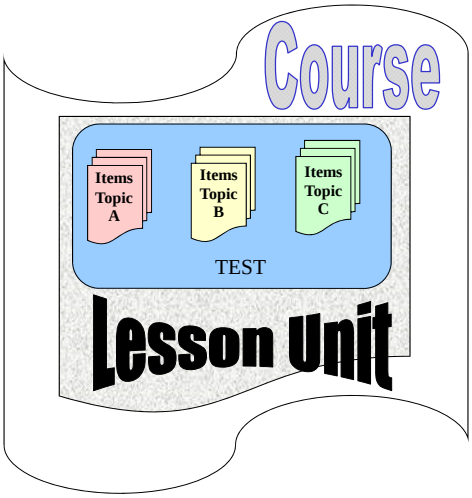
- Is the information sufficient & representative in order to dependably generalise to the domain we're interested in?
- What are the limits of the information's meaning?
- What does knowing the answers to these items tell us about person's knowledge of chapter and ability to function in domain?

- **HENCE, Multiple items to generate a robust estimate of competence in a domain**



PS: What implication if all the marks came from one section?

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Basic Principles of Test Design

- Know your domain—identify, describe what you want to teach and learn
  - reading is not one thing;
  - maths is not arithmetic
- Select rich ideas for important content
  - What are you really testing?
    - Generally content * cognitive function * difficulty

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Basic Principles of Test Design

- Consider cognitive demand
  - SOLO taxonomy; Bloom's revised taxonomy
- Consider logistics
  - Item formats (multiple styles),
  - Time, length;
  - Difficulty
- Agenda: enough information to be confident of any conclusions you want to draw
  - How many times does a student have to do something for us to conclude that she knows/can do it?

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Test Blueprint/Template

- A powerful way to organise writing items and reporting results
  - A test is a structured sample to permit valid inferences and actions about those content areas

	Style		Cognitive Demand	
Content Areas	Selected	Constructed	Surface	Deep
1.				
2.				
3.				
4.				

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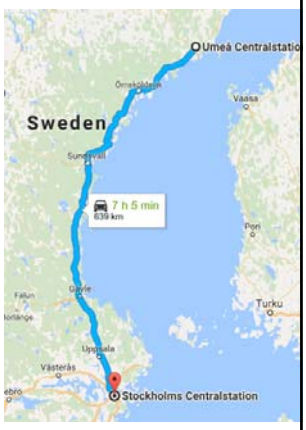
Progress

- The point of testing is not just to describe the lay of the land
- It is also to identify where on the journey a student is so that appropriate responses can be made
  - Signposts guide appropriate actions



Gävle kommun

Uppsala KOMMUN

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Educational challenge

- We are trying to encourage growth, development
- Young people are not always stable in 'learning' something
- The things we want students to learn are both simple and complex; and sometimes never easy
- Our estimates are not usually accurate
  - Multiple estimates, multiple judges, multiple opportunities, multiple methods

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The point of test items

- To generate evidence of competence around key parts of the domain to permit legitimate decision making that will be acceptable to students, parents, administrators, colleagues, funders, etc.
- Enough items of different types to eliminate alternative explanations
- Aligned to curricular practices and goals
- Challenging but doable

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Assumptions in Measurement

- If something exists we can measure it
- If we can't measure it, we may have failed in our ingenuity and ability to measure—it doesn't mean the thing doesn't exist
- We have an unfortunate tendency to treat as valuable only the things we can measure
  - We tend to treat as value-less anything we can't measure even if it does have value
- We have unfortunate tendency to settle for the easy to test parts as a proxy for the hard stuff

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Assumptions in Measurement

- All measures have some error
  - The length of a certain platinum bar in Paris is a metre
  - It is supposed to be 1/10,000,000th of the distance from equator to pole
  - **but** it is short by 0.2 mm according to satellite surveys
- Less error in measures of physical phenomena and more in social phenomena

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Assumptions in Measurement

- Reality has patterns partly because random chance has patterns in it
  - Toss a coin enough times and you will get patterns like this:

T H, T T H H, T T T H H H, T T T T H H H H

OR

T T T T T T T, H H H H H H H

  - If you measure something often enough, one of your results will appear to be non-chance, even though it actually is a chance event

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Assumptions in Measurement

- Chance plays a significant part in the results we generate
  - Sometimes the result we get could occur by chance anyway; just because something happens doesn't mean it would not have occurred anyway
  - If it is relatively unlikely to occur by chance then we say it is "*Statistically significant*"
    - So we create tables of how often things occur by chance as a reference point
  - We can estimate the probability (*p*) of something happening by chance and use this to determine whether our result is real or a chance artefact

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Measurement

- Properties are measured with tools that are calibrated into numerical scales
- Ratio Scale
  - E.g., length➔metres; weight➔kilograms;
  - The distance between any two markers is identical
  - There is a non-arbitrary zero-value
    - (there is a real world state that can be described as lacking any of the property of interest; but you can't have less than ZERO)
  - The point on the scale is a RATIO of a base unit and addition of the ratio values is possible
    - Full statistical analyses can be done

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Other types of scales

- Interval scale
  - Temperature in Celsius
    - (each point is 1/100th of distance between freezing and boiling point of fresh water at sea level)
  - Equal size distances between scale points
    - (1 to 5 is the same distance as 6 to 10)
  - Differences can be ratios:
    - 10 to 20 is twice the distance of 1 to 5
  - Zero point is arbitrary; negative scale points possible
  - Standard arithmetic can be applied to such scales especially concerning centre of distributions

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Other types of scales

- Ordinal scale
  - Rank ordered objects
    - 1st, 2nd, 3rd in a race
    - Tall, Taller, Tallest (not 1.80m; 2.00m; 2.26m)
    - Neutral, slightly agree, moderately agree, strongly agree
  - Distance between ranks or orders not necessarily equal
  - Challenge of how to do mathematical operations with some that is not continuous (non-parametric statistics)
    - We need evidence that distances are at least approximately equal to use rank orders—what evidence would be good?

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Other types of scales

- Nominal scale
  - Categorical or classification naming of objects that are qualitatively different to each other
    - Igneous, sedimentary, metamorphic
      - These can all weigh the same or have the same length but on critical features they are not identical
    - Male, female
    - Agree, disagree
    - Right, wrong
  - We can count the frequency of each category and compare the distribution of frequencies in samples

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Measuring Human mental properties

- Problem of measuring stuff 'in-the-head'
  - Our mental actions are difficulty to observe directly
- How do we know how much *xxx* you have?
  - Measure *xxx* with a recognised tool
- Measuring Tools for Social Science
  - Answers to Questions (paper or oral)
  - Self-reports
  - Observational Check Lists
- What scale properties do tools like these have?

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Measuring Human mental properties

- What kind of SCALE is the sum of items answered correctly?
- What kind of mathematical analysis can we use with that type of scale?
- We calculate means and standard deviations of test scores—do we have the right scale properties for this?
- What type of mathematical or statistical methods do we need to take into account chance factors?