Ch. 6: Test Development

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- Writing Test Items, question Formats
- Guessing & correction for guessing formula
- Cognitive Factors: Recall vs. Recognition
- Breakout Exercise: construct —> question
- Item Analysis: Difficulty, Discriminability, ICC
- Item Response Theory / Adaptive Testing
- SII (Strong Interest Inventory)

Writing test items

- Define what you are measuring (theory of the construct)
- Write many items that cover the C*ontent*
- Avoid very long items
- Use appropriate reading level
- Don't mix two concepts in one question.
- Vary the "response set" with both positively and negatively worded items

Test Item Formats

- Qualitative
  - Fill in the blank
  - Essay
- Quantitative
  - True / False…
  - Multiple Choice…
  - Rating / Category scales…

Dichotomous Format

- Aka "True/False" or "Yes/No" or "Binary"
- Pros: easy to write, administer, and score, good for basic facts. Avoids ambivalence.
- Cons: rote memorization, high scores due to guessing —> increased # of items, black & white thinking: not appropriate for complexity or nuance
- Summary: unsophisticated format - shouldn't be widely used for achievement testing

Poly[cho]tomous

- AKA “multiple choice”
- Target: correct answer
- Distractor: incorrect answers
- Pros: easy to administer (covers a lot of material quickly), easy to score, can handle shades of gray / nuance
- Cons: difficult to write, susceptible to guessing strategies, susceptible to “over studying”

Distractors?

- Too few distractors --> dichotomous
- Too many distractors --> slow, confusing
- Optimal is 3-5 distractors. Thus, most multiple-choice tests should have between 4 and 6 possible answers per question.
- Distractors should cover a wide range of abilities w/o being cute or trite

Guessing : Probability

- M = # of answer choices per question
- $P_{correct}$ with random guessing = 1/M
- On a dichotomous (T/F), P = ____
- On a multiple choice test with M answers per question, the probability = _____
- Total score from guessing:
  - $N_{questions}$ x $P_{correct}$

Guessing : Expected Score

- Probability of getting any item correct, using a random guessing strategy, p is equal to 1 divided by the # of answers.
- On a dichotomous (T/F) test the probability P = 1/2 = 50% = 0.5
- On a multiple choice test with M answers per question, the probability = 1 / M. For a 4 item test P= 1/4 = .25 = 25%
- Total score due to guessing = # of questions times average score per item or N * P.
- Example: an 100 item test with 4 answers = 25

Guessing impacts Validity

Correcting for Guessing

- Scores can correct for guessing.
- Goal: person randomly answering should get same score as someone who doesn’t answer.
- Expected score of someone who answers no questions = 0
- Expected score of someone who guesses randomly is N* (1/M)
- Correction Formula:
  - For every wrong answer, subtract 1/(M-1) points.

Correcting for Guessing : Example

- Example:
  - a 100 item test (N=100)
  - each question has 5 choices (M=5)
  - probability of right answer by guess? (P = 1/M = 1/5 = 20%)
- A student guessing on each item would average 20 correct (P*N = 0.2 * 100 = 20)
- Correction: subtract (1/M-1) points for each wrong answer = 1/(5-1) = 1/4 = 0.25 points.
- Adjusted score?

Correcting for Guessing - Real World

- Formula is simplistic
- College Board removed guessing penalty for AP exams in 2010
- SAT revisions in 2016
  - Removes penalty for Guessing
  - other changes:
    - Essay is optional
    - Vocabulary test changed

When should you guess?

- Almost always
- Worst case: if a correction formula is in use, and you truly have zero information for a given item, guessing has no effect
- However, it's likely you do have some knowledge. This increases your chances slightly above chance, giving you a positive expected score.

[di|poly]chotomous Issues

- Pros:
  - neutral, fair scoring
- Types of knowledge:
  - Recall vs. Recognition
  - Receptive vs. Expressive
- Skill =? test taking ability
- Solution: Essay test format

Accessing Knowledge

- Recalling information is different than Recognizing it
- Neuropsychology suggests different brain systems. Recall can be stronger or weaker than Recognition
- Issues for testing:
  - What type of access is involved in polychotomous testing?
  - Is it fair to test using a method which prefers one type over the other?

Recall vs. Recognition

Facts vs Opinions?

- Polychotomous : good for assessing factual information
- What about measuring opinions, preferences, styles?

Other question formats

- Likert Scale
- Category Rating Scale
- Visual Analogue Scale
- Checklists

Likert Format

- Asked to rate statements on an ordinal scale with a short list of answer choices
- Example:
  I am afraid of heights:
  5 strongly agree
  4 agree
  3 undecided
  2 disagree
  1 strongly disagree
- Numbers : can be shown or hidden

Likert : Neutral?

- Sometimes, want to avoid the middle (neutral, undecided) answer
- Example:
- I am afraid of heights:
  4 strongly agree
  3 somewhat agree
  2 somewhat disagree
  1 strongly disagree
- Like T/F, forces subject to take a position

Likert : Balance & Symmetry

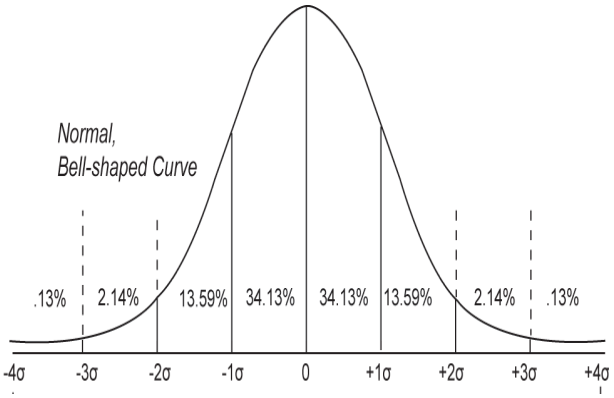
- Answers should be balanced & symmetrical
- I am afraid of heights:
  4 strongly agree
  3 somewhat agree
  2 neutral
  1 somewhat disagree
- Poor design
  - Answers will be biased towards 3 or 4

Likert Scales : 6 and 7 choices

1. Strongly Disagree
2. Disagree
3. Somewhat Disagree
4. Somewhat Agree
5. Agree
6. Strongly Agree

1. Strongly Disagree
2. Disagree
3. Somewhat Disagree
4. Neutral
5. Somewhat Agree
6. Agree
7. Strongly Agree

Ideal # of answers?



Category (Rating Scale) Format

- Similar to Likert format, but #s are used instead
- Pros -- responses are more precise than with Likert scales (10 vs. 5 or 6)
- Cons -- context effects stronger
  - Solution: clearly define endpoints
- Question: Precision vs. Accuracy?

Rating Scale - no anchors

- On a 1 to 10 scale how much do you like your partner?
  1
  2
  3
  4
  5
  6
  7
  8
  9
  10
- Issues:
  - Is 1 or 10 the highest?

Rating Scale - with anchors

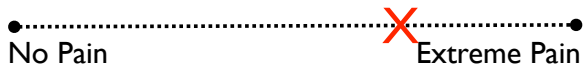
- On a 1 to 10 scale how much do you like your partner?
  1 Planning to break up
  2
  3
  4
  5
  6
  7
  8
  9
  10 Planning to get Married soon
- Issues:
  - Unbalanced (is 5 or 6 the middle?)
  - Interpretation? what does a "2" or "3" mean?

How many choices?

- Optimal # of choices is between 4 and 7
  - consistent with Miller's 7±2
- Using up to 10 choices is OK if
  - good anchors & examples are provided
  - raters are motivated or trained
- Otherwise, using 10+ choices leads to random responding

Visual Analogue Scale

- Similar to Category format, except use of a visual stimulus & graphical measurement
- Example:
  How much pain are you in right now?



- Pros: allows a precise, finely detailed response
  Cons: hard to score, precision vs. accuracy?

Checklists

- Checklists:
  - Agree/disagree with large # of statements
- Example

- "I am currently having trouble with…"
  - ☐ Money
  - ☐ Relationships
  - ☐ Appetite
  - ☐ Sleep
  - ☐ …

Polychotomous testing: Advice from Textbooks

Advice	% endorsing
Don't use "All of the above"	80%
Don't use "None of the Above"	75%
All choices should be plausible	70%
Negative wording shouldn't not be un-used	55%

Exercise: From Construct to Question

Ch. 6 - Part 2

Item Analysis

- In Ch 5 we discussed the reliability and validity *of the entire test*.
- Now we look at psychometrics of *individual test items*.
- Item Difficulty
- Item Discriminability

Item Difficulty

- How hard is this item?
- % who get the item correct "item easiness" ?

Too hard / Too easy

- Floor effect: many scores near the bottom range of possible scores
- Ceiling effect: many scores near the top range of possible scores

Ideal Difficulty

- Ideal= halfway between chance and perfect
  - for a 4-item multiple choice, chance = 25%, so optimum would be 62.5%
  - typical range is 30% to 70%
- Tests should contain wide variety of item difficulties, because people are different

Ideal Difficulty 2

- Mathematically, 30%-70% is optimum
- What about human / emotional issues?
  - Tests or items that are too hard?
  - Tests or items that are too easy?

Discriminability

- Difficulty = how many people answer correctly?
- Discriminability = who answers correctly?
- Does performance on one item correlate with overall test performance?

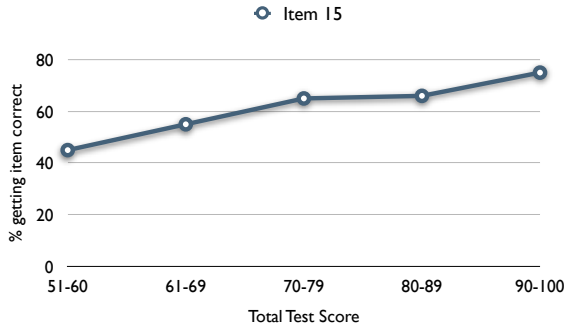
- Two ways
  - statistical
  - graphical

Discriminability - Statistical

- Extreme Group:
  - divide test takers into thirds
  - % correct : top third vs. bottom third
- Point Biserial
  - p.b. correlation between item and test score
  - low or negative values represent “bad” items

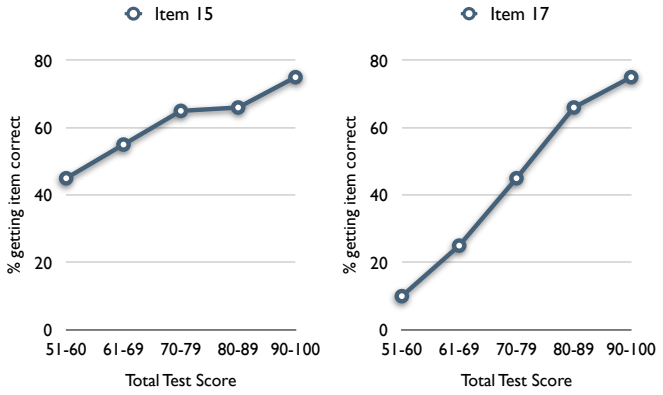
Discriminability - Graphical

- Item Characteristic Curve
- Graph % correct vs. total test score for one test item



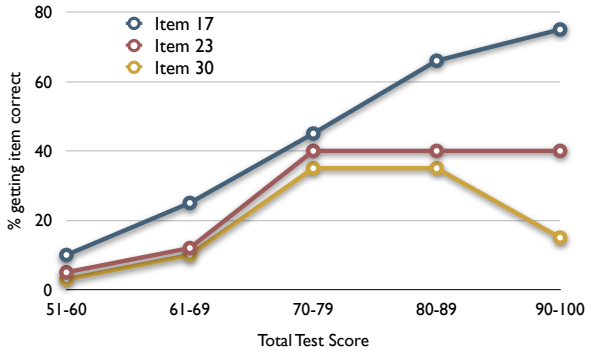
Item Characteristic Curve

- Different test items have different ICCs



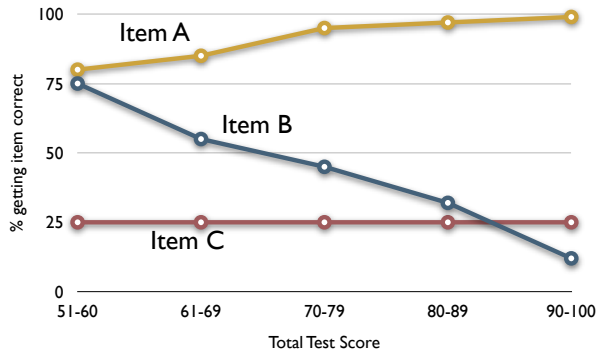
Item Characteristic Curve

- Good items show steady increase
- Bad items show decreases or flat spots



ICC Example

- Diagnose these problems:



Graph the ICC

- Item 1: What was the exact population of the town Bodie, California, in 1879?
  (A) 6142
  (B) 6143
  (C) 6144
  (D) 6145

- Correct answer = A

Graph the ICC

- Item 1: What is 0.34 times 0.27
  (A) 9.18
  (B) 0.61
  (C) 0.0918
  (D) 91.8

- "Correct Answer" = B

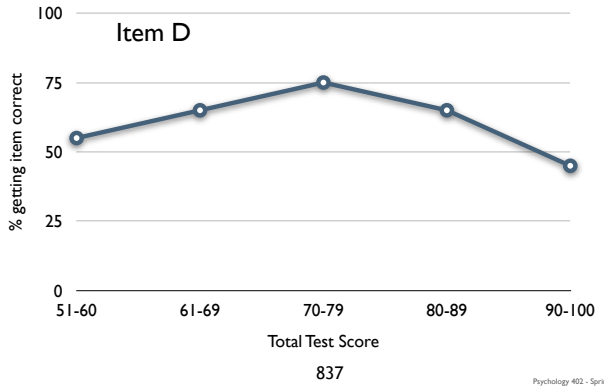
Graph the ICC

- Item 1: What is 1 + 2
  (A) 11
  (B) 21
  (C) 3
  (D) 0.3

- Correct answer = C

ICC Example

- The "Overstudying" problem:



Problems with multiple-choice items

Problem	Description
Unfocused Stem	The stem should include the information necessary to answer the question. One should not need to read the answers to figure out what question is being asked.
Negative Stem	The stem should exclude negative terms such as not and except
Window Dressing	Don't include information irrelevant to the question being assessed
Unequal Option Length	The Target and the Distractors should be about the same length.
Negative Options	Answer choices should not use words such as "not"
Clues to the Correct Answer	Vague terms such as might, may, and can could hint which option is correct, particularly in soft sciences where certainty is rare.
Heterogeneous Options	The Target and Dstractors should be in the same general category.

Item Response Theory (IRT)

- Classical Test theory
  - your ability = *number of items correct*
- IRT
  - your ability = *level of difficulty* at which you can perform
- IRT Model : probability of correct answer is modeled using several variables (for the test and the test-taker)
- IRT Procedures: computer-based *adaptive testing*

IRT / Adaptive Testing

- To cover different ability levels, tests need wide range of item difficulties
- For an individual, some items will be too easy / some too hard
- "old fashioned" solution = have several tests (easy…medium…hard) and pick a test based on pre-existing knowledge of person.
- IRT solution = one test that automatically detects person's level and gives questions mainly in that difficulty level.

IRT in the real world

- IRT is theoretically better
- Adoption in curriculum is slow
- some tests use it but vast majority do not

- Continuing research

External Criteria

- Internal Criteria = total test score
- External Criteria = thing that actually matters (e.g. "do you crash the plane")

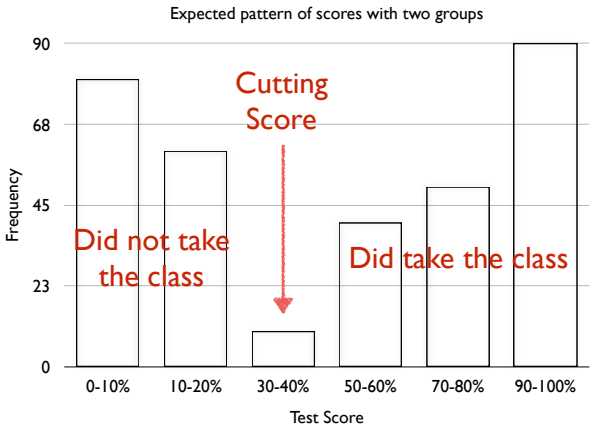
- Most Item Analysis still uses Internal criteria rather than the more correct External Criteria
- Why?

Criterion-referenced Test

- Instead of arbitrary criteria such as "70% = pass" use one with more validity.

- Criteria = the learning outcome(s) desired
- Method:
  - create a good test
  - give it to two groups of students
    - those who have had the material
    - those who have not
  - Determine cut-point score from histogram

Criterion-referenced Test



Limitations of Item Analysis

- Tests discriminate between levels of performance
- Statistics (difficulty and discriminability) don't tell why a person missed an item
- Items might discriminate well (statistically) but for the wrong reasons (educationally)
- Tests don't directly help people learn
- Tests can harm, if they dramatically change learning behavior (e.g. study for the test rather than the subject)

Example of a poor test item?

- What is 0.4 plus 0.3
  (A) 0.3
  (B) 0.4
  (C) 0.7
  (D) .07

- Is answering (A) better or worse than answering (D)?

Strong Interest Inventory (SII)

There will not be any questions about the SII on the midterm