INNOVATIVE SOLUTIONS TO IMPROVE THE QUALITY OF YOUR ITEMS

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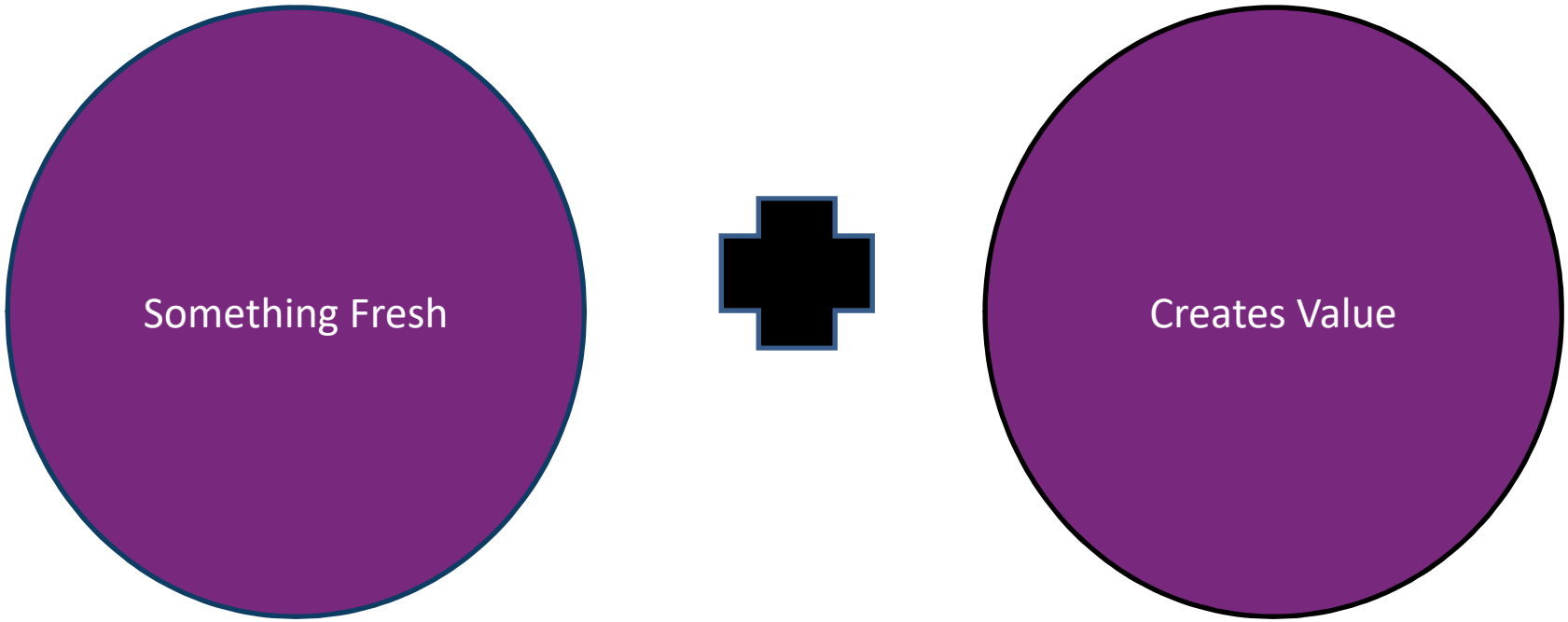
1. Define Item Types
2. Problem Based Presentation
3. Cognitive Mapping
4. Questions
Agenda

INNOVATION



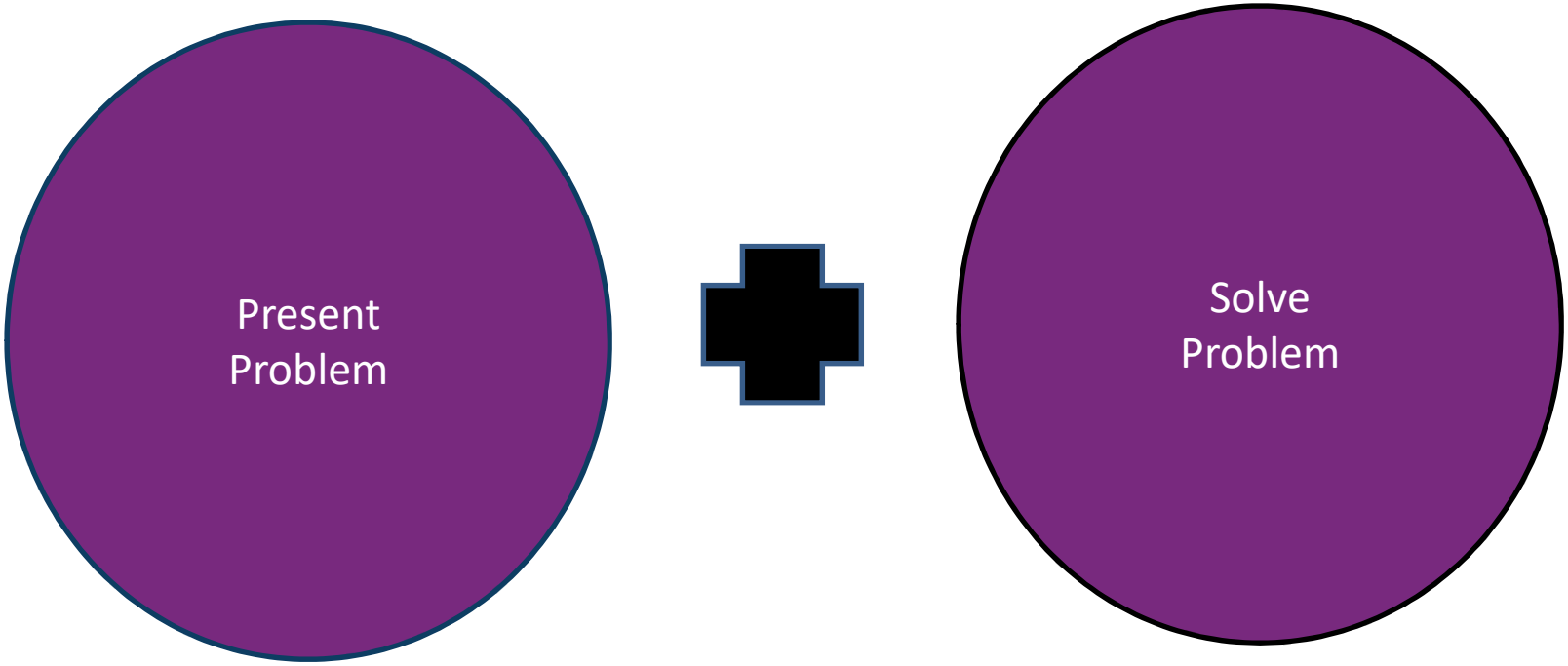
ITEMS ARE DIFFERENT

LEADING the CONVERSATION

- Single Select MCQ
- Multiple Select MCQ
- Constructed Response
- Hot Spot
- Drag & Drop
- Simulation
- Tables and Graphs
- Graphics
- Audio
- Video
- Other Media

PROBLEM BASED PRESENTATION

LEADING the CONVERSATION



ITEM WRITING RULES

APPLIED MEASUREMENT IN EDUCATION, 2(1), 37–50
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A Taxonomy of Multiple-Choice Item-Writing Rules

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A taxonomy of 43 multiple-choice item-writing rules is presented and discussed. The taxonomy derives from an analysis of 46 authoritative textbooks and other sources in the educational measurement literature. The analysis also leads to a "validity by consensus" for each rule. The taxonomy is viewed as a complete and authoritative set of guidelines for writing multiple-choice items.

SUMMARY OF ITEM WRITING RULES (HALADYNA & RODRIGUEZ 2013)

Content

- Base each item on one type of content and cognitive demand
- Use new material to elicit higher-level thinking
- Keep the content independent of one another
- Test important content. Avoid overly general content
- Avoid opinions unless qualified
- Avoid trick questions

Format Concerns

- Format each item vertically instead of horizontally

Style Concerns

- Edit and proof items
- Keep linguistic complexity appropriate
- Minimize the amount of reading in each item. Avoid window dressing

SUMMARY OF ITEM WRITING RULES (HALADYNA & RODRIGUEZ 2013)

LEADING the CONVERSATION

Writing the Stem

- State the central idea clearly and concisely in the stem and not in the options
- Word the stem positively, avoid negative phrasing

Writing the Options

- Use only options that are plausible and discriminating.
- Make sure that only one of these options is the right answer
- Vary the location of the right answer according to the number of options
- Place options in logical/numerical order
- Keep options independent; options should not be overlapping
- Avoid using "none of the above", "all of the above", "I don't know"
- Word the options positively, avoid negative words such as NOT

Avoid giving clues to the right answer

- Keep the length of the options about equal
- Avoid specific determiners such as always, never, completely absolutely
- Avoid clang associations, options identical to or resembling words in the stem
- Avoid pairs or triplets options that clue the test taker to the correct choice
- Avoid blatantly absurd, ridiculous options
- Keep options homogenous in content and grammatical structure

Make all distractors plausible

Avoid the use of humor

USE PLAUSIBLE DISTRACTORS

Problem

- What is the capital of France?
  - A. Lyon
  - B. **Tokyo**
  - C. Orleans
  - D. Paris
- Which of the following are the sweetest green apples?
  - A. Macintosh
  - B. Golden Delicious
  - C. Empire
  - D. Red Delicious
- Which symptom may be experienced during a stroke?
  - A. trouble speaking
  - Enter more options here

Potential Solutions

- Look up items in that area and possible use those distractors
- Use seminal references
- Think of common errors that may occur in their roles especially when training colleagues or observing entry level professionals
- Ask for help – another SME

INCREASE COGNITIVE LEVEL

LEADING the CONVERSATION

Problem

- What is 1+1?
- What is normal blood pressure?
- What are the ADA requirements for a door opening?
- How many lug nuts are minimally required for a tire mounting?
- What is the safe amount of tension when building a bridge?

Potential Solutions

- Define and use actual situational variables
  - e.g., medicine = vitals
  - e.g., finance – financial metrics (operating budget, expenses, revenue, profit)
- Don't use trivial situational descriptions
  - A family is distracting the doctor when the doctor is applying a treatment to the patient.

CUEING

LEADING the CONVERSATION

Problem

- In 1776, the Declaration of Independence was signed. What year was the Declaration of Independence signed?
  - A. 1776
  - B. 1779
  - C. 1789
  - D. 1812

Solution

- Remove the cueing in the stem (e.g., 1776)
- Remove it from the correct answer (requires rewrite)

TRIVIAL/TEACH STEM

Problem

- There are many opinions on pizza dough hydration. In fact, some argue that 60% is the perfect dough hydration. What is the most common pizza topping?

Solution

- Ask yourself what can be removed?
- Are any sentences before the interrogative necessary to answer the question?

LENGTH OF OPTIONS

LEADING the CONVERSATION

Problem

- Who is your favorite comedian?
  - A. Elmo
  - B. Lisa Marie
  - C. Christopher Julius Rock III
  - D. Fluffy – Gabriel Iglesias

Solution

- Reduce
  - Length of options
  - Words
- Ensure
  - Options and words are about the same length/number

PARALLEL FORMATTING

Problem

- In order to move a bicycle forward, what action needs to be performed?
  - A. Run
  - B. To Walk
  - C. Peddling
  - D. Brushed
- Which US government agency is responsible for categorizing illnesses?
  - FBI
  - Center for Disease Control
  - EPA
  - National Aeronautics and Space Administration (NASA)

Solution

- Use the same grammar structures
- Use the same "rules"

REPETITIVE WORDS IN OPTIONS

Problem

- How much water is required for optimal dough hydration
  - 60 percent
  - 40 percent
  - 80 percent
  - 30 percent
- How many detrimental attacks occurred on Thursday?
  - 10 detrimental attacks
  - 20 detrimental attacks
  - 50 detrimental attacks
  - 99 detrimental attacks
- How many Sesame Street characters were spotted last night?
  - 10 Elmos
  - 20 Elmos
  - 30 Elmos
  - 40 Elmos

Potential Solution

- Eliminate repeated words in options
- Add repeated words in options into the stem

REPETITIVE WORDS IN OPTIONS

Problem

- Which Sesame Street character is NOT required?
  - A. Elmo
  - B. Cookie Monster
  - C. Burt
  - D. Big Bird
- For a Sommelier, which step is not required?
  - A. Smelling
  - B. Sipping
  - C. Tasting
  - D. Swishing

Potential Solution

- Write in the positive
- Substitute NOT with other words
  - eliminate, prohibit, restrict
  - Optional
- Write a new question

NONE OF THE ABOVE/ALL OF THE ABOVE

Problem

- How many glasses of wine is necessary to complete this session?
  - A. 1
  - B. 2
  - C. 3
  - D. All of the above
- Which chocolate has the least sugar content?
  - A. White
  - B. Dark
  - C. Milk
  - D. None of the Above

Potential Solution

- Replace with a plausible option

ACRONYMS

Problem

- Which of the following agencies oversees food safety?
  - A. USDA
  - B. CDC
  - C. FDA
  - D. OHSA

Which of the following

- Which of the following agencies oversees food safety?
  - A. United States Department of Agriculture (USDA)
  - B. Centers for Disease Control (CDC)
  - C. Federal Drug Administration (FDA)
  - D. Occupational Safety and Health Administration (OSHA)

Potential Solutions

- Determine prior to item writing how to manage acronyms
  - Spell them out
  - Don't spell them out
- Tips
  - If references don't spell acronyms out, consider using the acronym
  - If majority/all SMEs believe everybody should know the acronym, consider using the anonym

EXPRESSING MEASUREMENT UNITS

Problem

- Which temperature is considered absolute zero?
  - A. -273.15 degrees Celsius
  - B. -459.67 degrees Fahrenheit
  - C. -273.15C
  - D. -273.15 °C
- What is the length from the bathroom opening to the bedroom?
  - A. 10cm
  - B. 10 centimeters
  - C. 1 foot
  - D. 1 ft (.33 meters)
- How much does a the average suitcase weigh?
  - A. 40 lbs
  - B. 40 pounds
  - C.18 kilos
  - D. 18 kg

Potential Solutions

- Determine ahead of time how measurement units and other standardized information should be expressed
- Tips
  - Develop a style guide
  - Use the seminal literature/references
  - Use SMEs to make final determination

NUMERIC/LOGICAL ORDER

Problem

- According the 2012 standard, how many outlets should there be?
  - A. 20
  - B. 10
  - C. 30
  - D. 50
- What year did the Cuban Missle Crisis occur?
  - 2010
  - 1962
  - 1900
  - 1822

Potential Solution

- Avoid offensive content
- Examples
  - Avoid personal pronouns(she, he)
    - replace with the
  - Avoid religious references
    - eliminate
  - Replace with more acceptable words
    - mail carrier with mailman
  - Avoid humor

OFFENSIVE CONTENT

Problem

- A mailman who practices Jainism wanted to purchase shampoo for his dog. What key ingredient should be in the shampoo for a healthy dog hair?
  - A. Oatmeal
  - B. Paraben
  - C. Pthalates
  - D. Formaldehyde

Potential Solution

- Avoid offensive content
- Examples
  - Avoid personal pronouns(she, he)
    - replace with the
  - Avoid religious references
    - eliminate
  - Replace with more acceptable words
    - mail carrier with mailman
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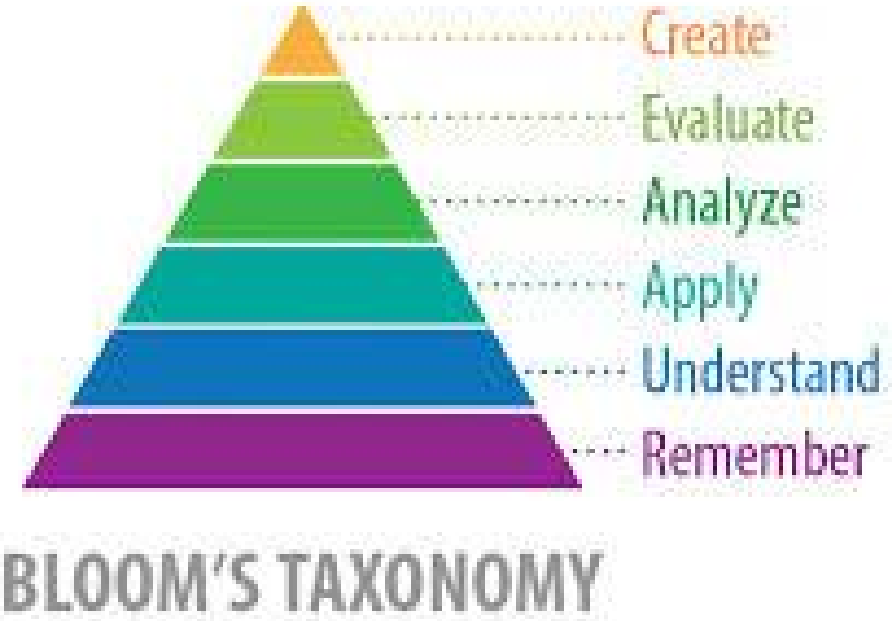
COGNITIVE LEVELS



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HOT SPOT ITEM EXAMPLE

What *city* is the capital of *France* ?

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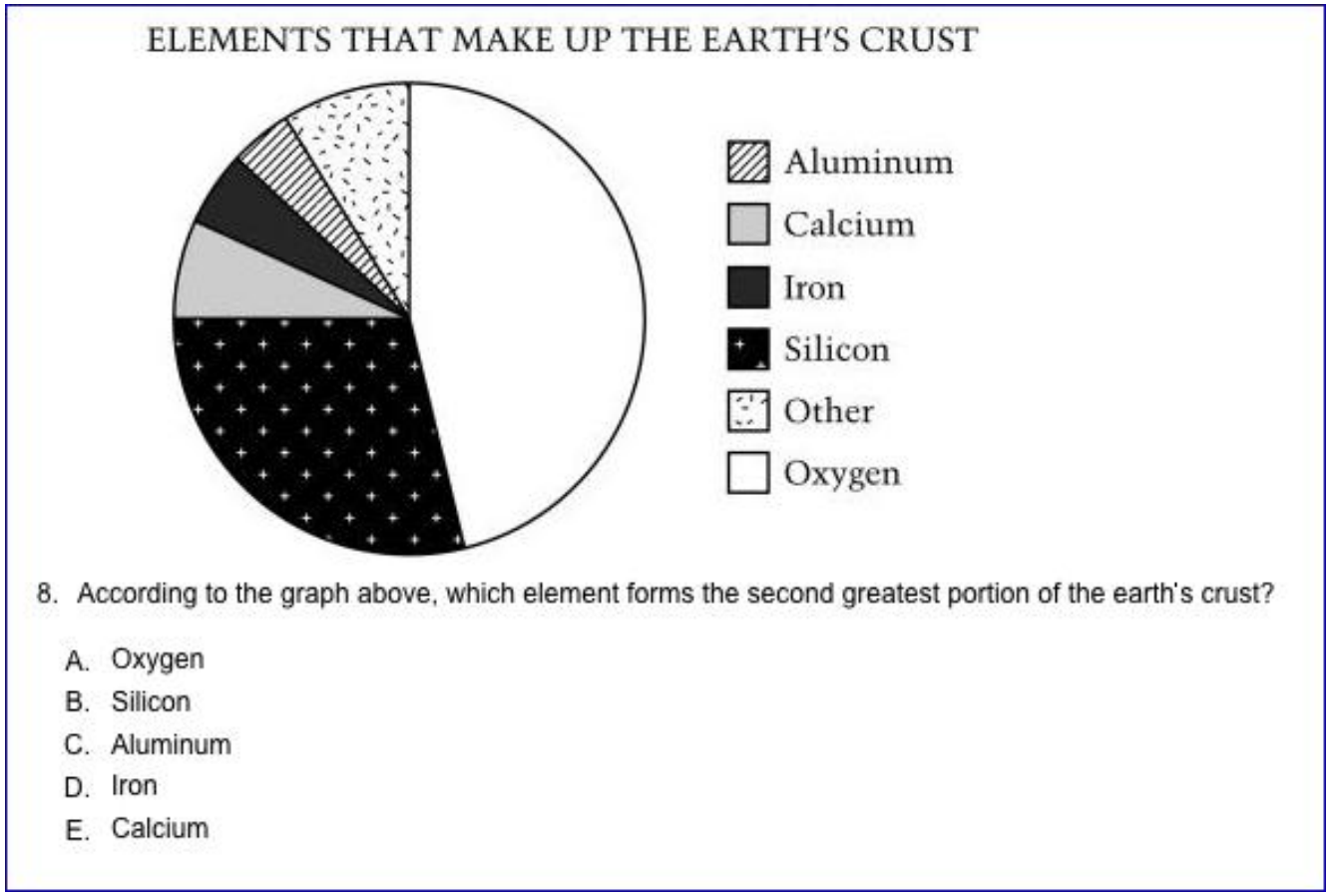
ITEMS WITH GRAPHIC

LEADING the CONVERSATION



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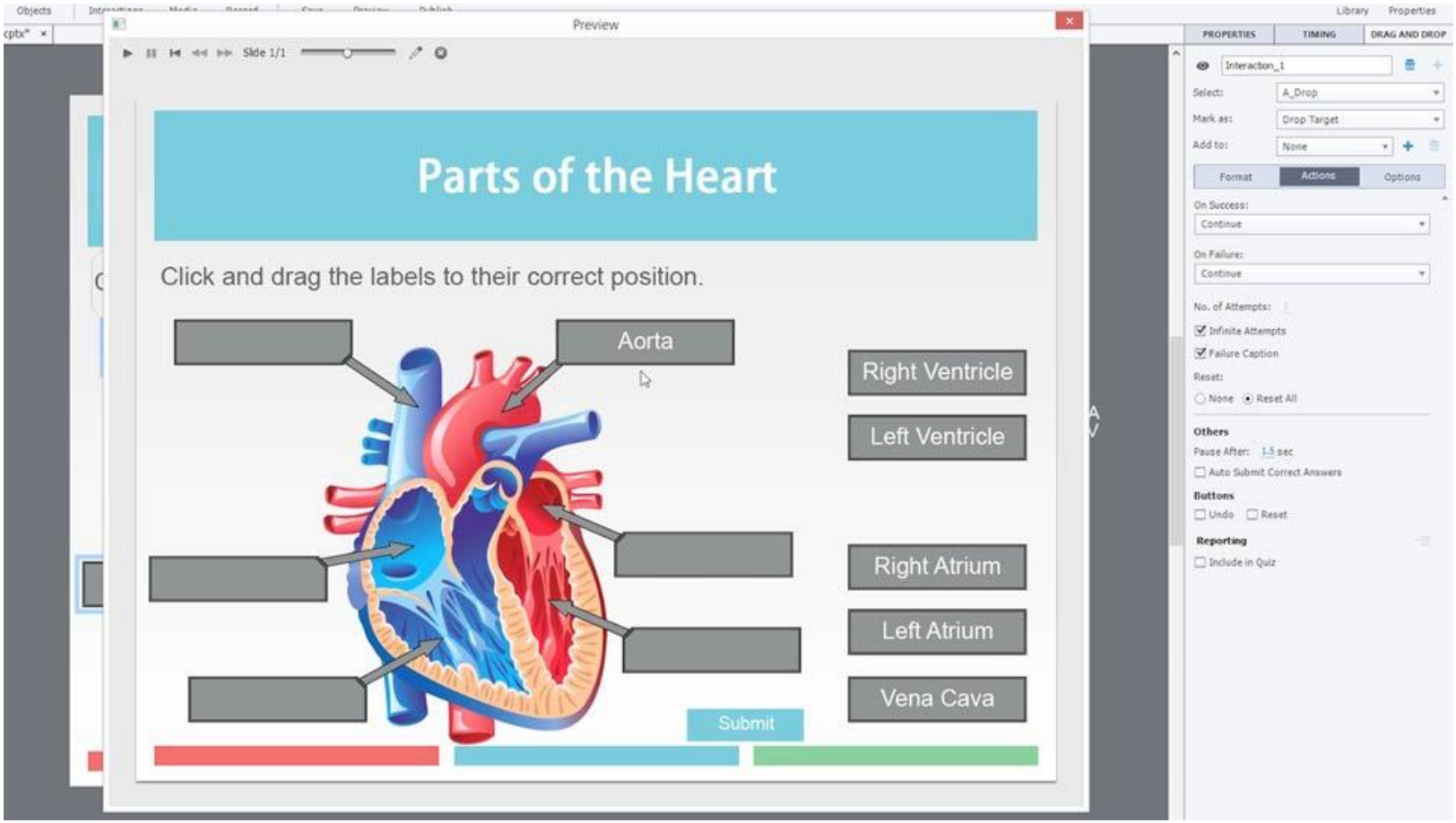
LEADING the CONVERSATION



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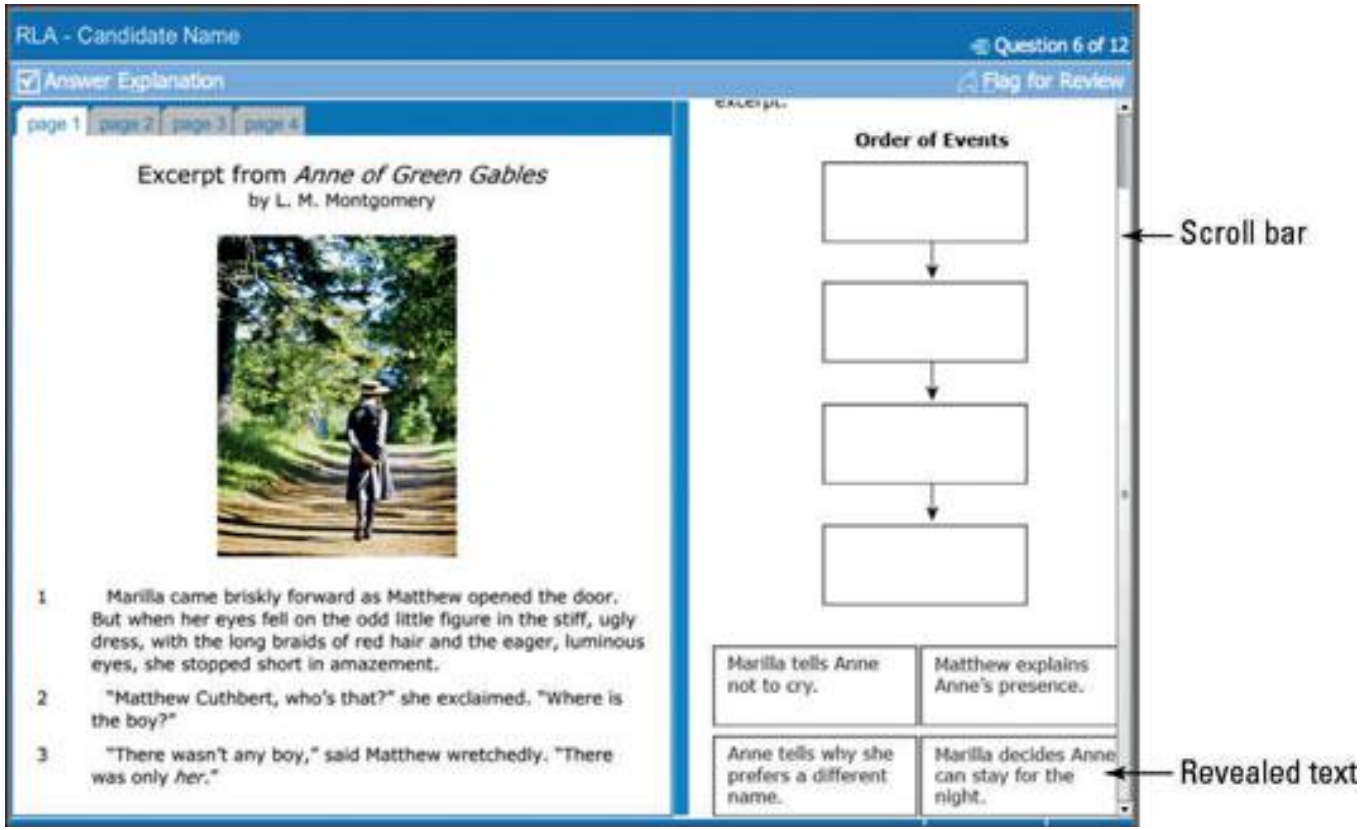
DRAG AND DROP ITEM



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AND NOW FOR SOMETHING COMPLETELY DIFFERENT…. COGNITIVE MAPPING

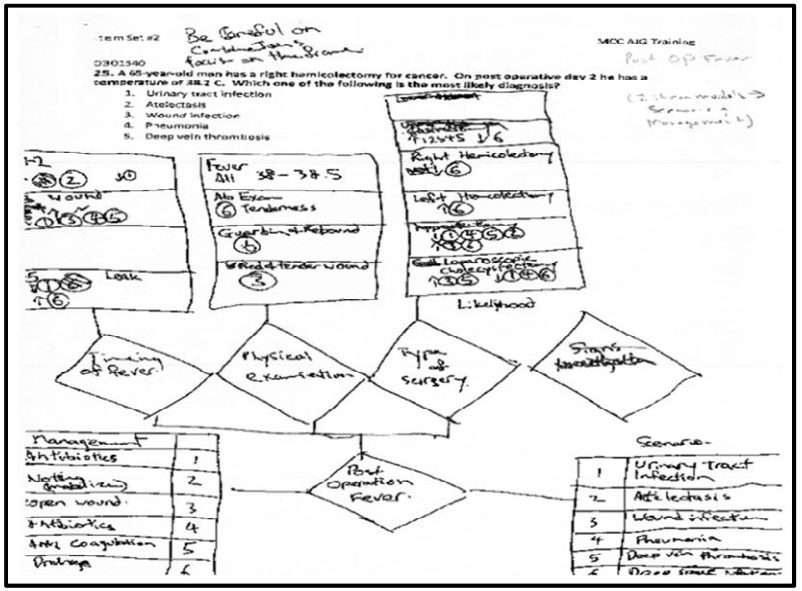
- Common item writing rules are predicated on the development of items using a conventional committee-based approach
- Content experts, after training, are asked to write targeted items in very specific areas of the blueprint
- What if we shifted our focus from the micro- (i.e., item) to the macro-level (i.e. problem or scenario) to develop items using cognitive mapping?

ITEM DEVELOPMENT – PRESENT VS. FUTURE?

LEADING the CONVERSATION

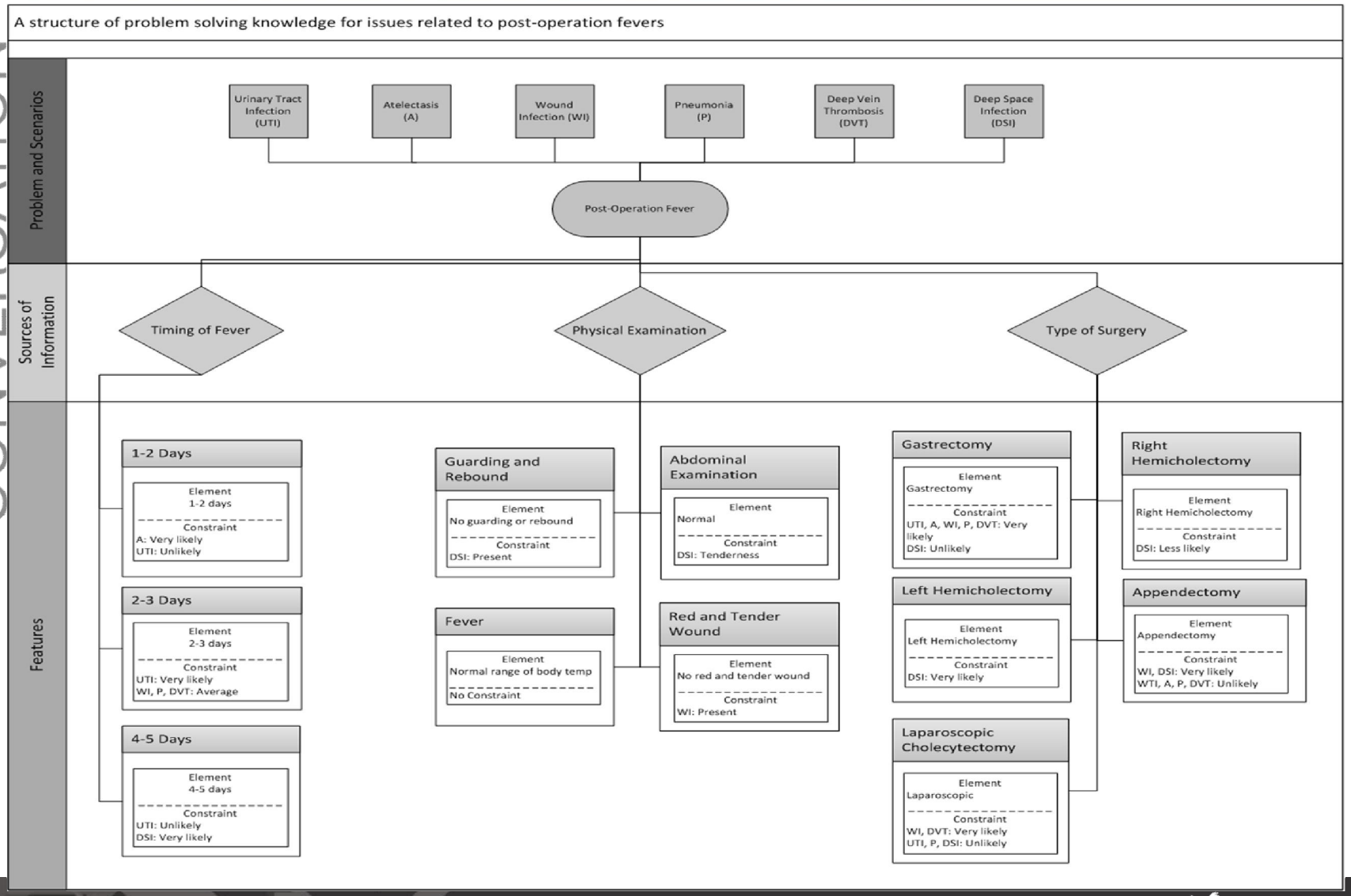
PRESENT

FUTURE?



"PROBLEM" DEVELOPMENT – COGNITIVE MAPPING

LEADING the CONVERSATION



WHAT IS A COGNITIVE MAP?

LEADING the CONVERSATION

- **Complex diagram that highlights the knowledge, skills and content required to make a medical diagnosis or manage a patient ("to obtain a correct answer")**
  - Deconstruction of a reasoning process for a specific problem (e.g.: clinical presentation)

STEPS IN DEVELOPING A COGNITIVE MAP

LEADING the CONVERSATION

- **Select a task for the problem (e.g., diagnosis)**
  - Chest trauma
- **Develop a list of correct answers for the problem**
  - Cardiac tamponade
  - Left-side tension pneumothorax
- **Identify sources of information**
  - Location (e.g., left, lower chest)
  - Hemodynamics (e.g., BP 70/60, HR 130, RR 20)
  - Physical exam (e.g., good air entry bilaterally)
- **Document your model (in *Ibutler*)**

WHAT IS AN ITEM MODEL?

LEADING the CONVERSATION

- **We then create item models using the cognitive map content; an item model is a template or a mould of the assessment task (i.e., it's a target where we want to place the content for the item)**

A 54-year-old woman has a <**TYPE OF SURGERY**>. On post-operative day <**TIMING OF FEVER**>, the patient has a temperature of 38.5°C. Physical examination reveals <**PHYSICAL EXAMINATION**>. Which one of the following is the best next step?

<**TYPE OF SURGERY**> Gastrectomy, right hemicolectomy, left hemicolectomy, appendectomy, laparoscopic cholecystectomy

<**TIMING OF FEVER**> 1-6 days

<**PHYSICAL EXAMINATION**> Red and tender would, guarding and rebound, abdominal tenderness, calf tenderness

DOCUMENTING YOUR COGNITIVE MAP

Chest Trauma		
Management	Cardiac Tamponade	Left side tension pneumothorax
Location	• Stabbed in left lower chest • Stabbed in left upper abdomen • Kicked multiple times in sternum	• Stabbed below the clavicle on the left side • Stabbed multiple times to the left back • Shot in the left mid chest
Hemodynamics	• BP 70/60 HR 130 RR 20 • BP 85/78 HR 140 RR 22 • BP 88/80 HR 142 RR 25	• BP 95/70 HR 140 RR 30 • BP 90/50 HR 140 RR 32 • BP 88/50 HR 142 RR 28
Physical exam	• Good air entry bilaterally, with muffled heart sounds • Decreased air entry to bases, with faint irregular heart sounds • Good air entry bilaterally with no appreciable heart sounds	• No air entry on left side, with normal heart sounds • Minimal air entry on left side, with pronounced systolic ejection murmur • Reduced air entry on left side with hyperresonance on percussion

AIG MAP EDITOR

EXIT

STEP 1: OBJECTIVE & TASK

Objective: Chest Trauma Diagnosis

Task:

STEP 2: CORRECT OPTIONS LIST

1 Cardiac tamponade

2 Left-side tension pneumothorax

DISTRACTORS

	SHOW WITH	EXCLUSIONS
X1 Cardiac tamponade		
X2 Left-side tension pneumothorax		
X3 Myocardial infarction		
X4 Pulmonary contusion		
X5 Splenic injury		

STEP 3: STEM

New variable

A 68Kg, 50-year-old security guard was during an altercation with another man. He is immediately brought to the hospital where his vitals are as follows: blood pressure E:BP, heart rate , and respiratory rate . He has D:AIR_ENTRY with C:HEART_SOUNDS. His neck veins are B:NECK_VEINS and his trachea A:TRACHEA.

What is the most likely diagnosis?

STEP 4: LEAD-IN QUESTION

A:TRACHEA

	CORRECT ANSWERS	EXCLUSIONS
A1 is midline		
A2 is deviated to the right side		

B:NECK_VEINS

	CORRECT ANSWERS	EXCLUSIONS
B1 distended		
B2 not distended		
B3 not visible		

C:HEART_SOUNDS

	CORRECT ANSWERS	EXCLUSIONS
C1 faint heart sounds		
C2 no heart sounds		
C3 pronounced systolic ejection murmur		
C4 hyperresonance on percussion		

D:AIR_ENTRY

	CORRECT ANSWERS	EXCLUSIONS
D1 good air entry		
D2 decreased air entry to the bases		
D3 good air entry bilaterally		
D4 no air entry on the left side		

E:BP

	CORRECT ANSWERS	EXCLUSIONS
E1 70/60		
E2 85/78		
E3 88/80		
E4 95/70		
E5 90/50		

SAVE CLONE PREVIEW

Generate from set of 30 questions GENERATE

AUTOMATED ITEM GENERATION

LEADING the CONVERSATION

- After the item model is specified, the information is systematically combined to produce new items
- To accomplish this complex, combinatoric task, an item generation software called IGOR (Item GeneratOR) was created
- IGOR was programmed using Sun Microsystems Java
- Cognitive modeling can still be used to improve overall item quality WITHOUT the AIG component

COGNITIVE MAPPING – EARLY LESSONS LEARNED

- **Thousands of items generated across 70+ cognitive maps**
- **Predictive identification accuracy ranges from 32-52% across experts with an average accuracy rate of 42%**
  - Physicians can't tell the difference between AIG and traditional items
- **Pretested AIG items (~600) cover shallow areas of our pool very well**
  - Stronger distractors – directly attributable to the AIG process
- **Retention rates are comparable and even higher than traditional items**
- **Item development processes and overall quality have improved drastically with cognitive mapping, irrespective of AIG**
  - Due to the effort required in creating a cognitive map not only for correct response, but also for the distractors (clinical reasoning errors)

MORE INFORMATION

MedicalTeacher_Pugh et al_2016.pdf - Adobe Acrobat Reader DC

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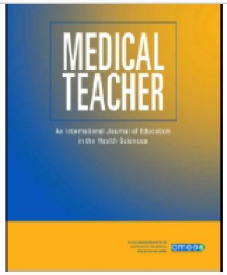

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Using cognitive models to develop quality multiple-choice questions

Debra Pugh, Andre De Champlain, Mark Gierl, Hollis Lai & Claire Touchie

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FINAL TIPS

- Form a committee/subcommittee to address and determine item writing rules and style guides
- Develop style guide for item writing