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Writing Multiple Choice Questions (MCQ)

Guidelines for Program Faculty in Creating Test Items

Julie Gill, PhD, RT(R)(QM)

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Types of Evaluation

- Formative - conducted to provide learners with evaluative information useful in improving
- Summative - provides information on the ability of the learner to do or know what he/she is supposed to do or know

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Formative vs. Summative Evaluation

"When the cook tastes the soup, that's formative; when the guests taste the soup, that's summative."
Robert Stakes

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Purposes of Testing - Individuals

- Evaluating learner progress toward achieving educational goals
- Identifying areas that require remedial activity
- Assigning grades
- Identifying scholarship recipients

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Purposes of Testing - Institution

- Tool for program evaluation
- Identifying placement into a certain course
- Identifying strong or weak areas of curriculum

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Purposes of Testing – State or Nat'l

- To certify competence (ARRT)
- To license individuals for practice in an occupation or profession

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Types of Test Items

- Multiple Choice – allows the greatest flexibility
- Matching – most effective for assuring that students understand similarities and differences among closely related concepts
- True-False

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Types of Test Items

- Short Answer – must have an excellent question stem
- Sentence Completion – where to put the blank?
- Essay – good at gauging the depth of a learner's knowledge about a particular topic

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Multiple Choice Questions **Cons**

- Tests for recognition instead of recall or the ability to arrive at answer without cues
- Cannot assess practical (clinical) or interpersonal skills
- Encourages MCQ study habits like rote memorization
- Scores can be contaminated by "testwiseness" and general reading skills

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Multiple Choice Questions **Pros**

- Allows for broad content coverage: many items can be presented & answered in a short period of time
- Best for knowledge & cognitive skills
- Easy to administer to groups
- Can compute statistics to help evaluate item quality
- Objective scoring: scores are very reliable

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Anatomy of a MCQ

- 2 parts:
  - stem – present a problem situation
  - alternatives, options, or choices – provide possible answers
- Stems may be in the form of a question or an incomplete statement
- Alternatives include the correct answer and several plausible wrong answers, called distractors

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Example

What is another name for the navicular carpal bone? ---- *stem*

Triquetrum
Semilunar } *distractors*
Cuneiform
Scaphoid ---- *correct answer*

options

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Types of MCQs

- Direct Question
- Incomplete Statement
- Exhibits
- Negatively Worded Items
- Combined Responses

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Direct Question

Which of the following refers to the degree of blackening seen on the radiographic image?

A. Radiographic contrast
B. Radiographic density
C. Radiographic intensity
D. Radiographic sharpness

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Incomplete Statement

The degree of blackening seen on a radiographic image is referred to as radiographic

A. contrast
B. density
C. intensity
D. Sharpness

Alphabetize options?

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Incomplete Statement

- The key to writing a good incomplete statement is to have the stem convey a complete problem.

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Incomplete Statement Unfocused Stem

The degree of blackening seen on a radiographic image

A. must be controlled by the kVp setting
B. is called contrast
C. is frequently caused by scattered radiation
D. is referred to as radiographic density

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Incomplete Statement

- A good way to tell if a stem is unfocused is to mask the options & ask whether a knowledgeable learner could determine the answer by reading just the stem.
- An even better way to focus a stem is to first write it as a direct question, and then convert it to an incomplete statement – **but** only if there is a good reason to do so, e.g. making the item easier to read.

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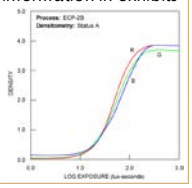
Exhibits

- Both the incomplete statement and direct question formats can be used for items that display information in exhibits such as tables, graphs, drawings, medical images, and photographs.



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Exhibits

- In medical imaging and radiotherapy, exhibits can present information that is clinically relevant and concise.
- Exhibits can also be used to assess critical thinking.

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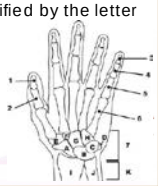
Exhibits

- Letter A identifies the
- The scaphoid is identified by the letter
- Which letter identifies the most commonly fractured carpal bone?



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Exhibits

A bone densitometry scan of the lumbar spine produces the BMD measurements below. What might explain these results?

region	g/cm2
L1	0.98
L2	0.92
L3	0.96
L4	1.01

A. Osteoporosis
B. Scoliosis
C. Severe facet sclerosis at L2
D. Vertebral fracture at L1

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Knowledge & Skills Assessed with Exhibits

- Medical images, anatomical illustrations, positioning photographs or diagrams - Recognize anatomy, physiology, or pathology; identify positions/ projections; recognize positioning errors; identify artifacts; evaluate image quality

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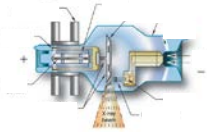
Knowledge & Skills Assessed with Exhibits

- Drawing or photographs of equipment and instrumentation - Recognize parts, explain how systems function, explain QC procedures, evaluate instrument settings



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Knowledge & Skills Assessed with Exhibits

- Models of scientific principles of processes (x-ray tissue interactions, dose-response curves) - identify & label parts, infer relationships, determine words or equations that correspond to a model or curve

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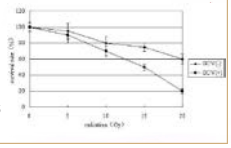
Knowledge & Skills Assessed with Exhibits

- Tables or graphs with technical factors, technique charts, equipment specs, results of QC tests - Evaluate technical factors, calculate certain results, interpret and evaluate QC data, draw inferences, interpret data and use charts



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Negatively Worded Items

- Sometimes it makes perfect sense to write test items that emphasize what **should not** be done (contraindications or when some action must be avoided because it could be harmful)
- A major limitation is that quick readers may miss the negative phrasing and choose an incorrect answer. To help prevent this, **always highlight the negative word**

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Negatively Worded Items

Which of the following will NOT result in grid cut-off?

A. An off-center tube
B. A grid used outside of the recommended focal range
C. A tube that is perpendicular to the grid lead strips
D. Grid motion being started before the exposure is made

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Combined Response

- Consists of a stem followed by three or four possible responses, one or more of which is correct.
- Best used when multiple things are correct, and learners should be able to consider them simultaneously.

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Combined Response

- For example, when considering: (1) how different technical factors affect contrast, density, or other imaging factors; (2) how multiple symptoms must be present at the same time in order to make a diagnosis; (3) how different events jointly interact to influence an outcome.

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Combined Response

Which of the following interactions between x-rays and human tissue affect the quality of the radiographic image?

1. Photodisintegration
2. Compton effect
3. Photoelectric effect

A. 1 & 2 only
B. 1 & 3 only
C. 2 & 3 only
D. 1, 2 & 3

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Combined Response

- Some educators mistakenly believe that combined-response items assess critical thinking.
- Although it does require more mental processing, it's the type of skill that is easily taught in "test coaching" classes.

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Writing the Stem

- Make it clear
- Target appropriate reading level
- Keep it short, but not too short

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What's Wrong?

- According to the NCRP, the occupational dose equivalent limit for a pregnant radiographer should NOT exceed how many rem during the gestation period?
- Is 'how many rem' needed?
- Is 'during the gestation period' needed?

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Solution

- According to the NCRP, what is the occupational dose equivalent limit for a pregnant radiographer?

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What's Wrong?

The navicular

A. is also known as the scaphoid
B. can be located in a patient's skull
C. is a small bone found in the knee
D. is a blood vessel

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Solution

What is another name for the navicular carpal bone?

A. Cuneiform
B. Scaphoid
C. Semilunar
D. Triquetrum

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Writing the Distractors

- Make **one** correct answer.
- Do **not** give unintended clues.
- Avoid "all of the above" and "none of the above."
- Make structure parallel
- Arrange in order
- Vary the correct answer's position
- Be careful with opposites

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What's Wrong?

A lateral malleolus is associated with an

A. ankle
B. hip
C. knee
D. shoulder

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What's Wrong?

An electrical transformer can be used

A. alternating current is changed to direct current
B. it converts electrical energy into mechanical energy
C. storing electricity
D. to increase the voltage of alternating current

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What's Wrong?

A radiation dose of 1000 rads is delivered over 5 days. What is the dose rate?

A. 25 rads/day
B. 200 rads/day
C. 100 rads/day
D. 40 rads/day

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What's Wrong?

What should be changed in order to increase the depth of penetration of an ultrasound beam?

A. Decrease frequency
B. Increase frequency
C. Increase the velocity
D. Decrease the amplitude

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Item Review Checklist

- Does the stem present a single, clearly formulated problem?
- Is the stem stated in simple, clear language?
- Is the stem worded so there is no repetition of material in the alternatives?
- Is the stem stated in positive form whenever possible?

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Item Review Checklist

- Is the item written in a manner that is unbiased in terms of diversity factors?
- If negative wording is used in the stem, is it highlighted in some form?
- Is the intended answer correct or clearly best, and is there only one correct answer?

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Item Review Checklist

- Are all the options grammatically consistent with the stem?
- Are all the options parallel in structure and form?
- Are the options free from verbal clues to the correct answer?
- Is the correct answer about as long as one or more of the distractors?

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Item Review Checklist

- Have *all of the above* and *none of the above* options been avoided?
- Is the position of the correct answer varied so there is no detectable pattern?
- Are alternatives in logical order when appropriate or in random order when called for?
- **In general, does the item's format and grammar facilitate efficient and easy test taking?**

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Thanks and Happy Test Writing!

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