



UNIVERSITY of
Western States

Center for Teaching and Learning

Test Construction

Please review the [tutorial](#) provided by Weber State University (WSU Online, 2021). The modules on planning, developing, and implementing a test are excellent resources for test construction.

Guidelines for Writing Multiple Choice Questions

Multiple choice tests are a popular assessment tool in higher education (Scully, 2017). MC tests are easy to administer and grade which is particularly important in large classes. Faculty are also able to assess students on a greater percentage of course content. Finally, faculty are able to access the performance of test items to make improvements for future assessments (Scully, 2017).

MC tests are not without their challenges. According to Zimmerman (2015), MC tests are laborious to construct. As discussed in the Test Construction section above, to develop a MC test create a [Test Blueprint](#). Below are recommendations for developing multiple choice questions.

Constructing Effective Alternatives (This information is derived from Brame, 2013)

1. **All alternatives should be plausible.** The function of the incorrect alternatives is to serve as distractors. Alternatives that are implausible don't serve as functional distractors and thus should not be used. Common student errors provide the best source of distractors.

IMPLAUSIBLE ALTERNATIVES

Who gathered the data that helped reveal the structure of DNA?

- A. Francis Crick
- B. George Washington
- C. James Watson
- D. Rosalind Franklin
- E. Snoopy

Note: B and E are not functional distractors and so do not contribute to the item.

2. **Alternatives should be stated clearly and concisely.** Items that are excessively wordy assess students' reading ability rather than their attainment of the learning outcome.

WORDY ALTERNATIVES

The term hypothesis, as used in research, is defined as

- A. A conception or proposition formed by speculation or deduction or by abstraction and generalization from facts, explaining or relating an observed set of facts, given probability by experimental evidence or by factual or conceptual analysis but not conclusively established or accepted.
- B. A statement of an order or relation of phenomena that so far as is known is invariable under the given conditions, formulated on the basis of conclusive evidence or tests and universally accepted, that has been tested and proven to conform to facts.
- C. A proposition tentatively assumed in order to draw out its logical or empirical consequences and so test its accord with facts that are known or may be determined, of such a nature as to be either proved or disproved by comparison with observed facts.

Source: Steven J. Burton, Richard R. Schweske, Paul F. Merrill, and Bud Wood. How to Prepare Better Multiple Choice Test Items: Guidelines for University Faculty. 1991.

3. **Alternatives should be mutually exclusive.** Alternatives with overlapping content may be considered "trick" items by test-takers, excessive use of which can erode trust and respect for the testing process.

OVERLAPPING ALTERNATIVES

How many chromosomes are found in a typical human cell?

- A. 12
- B. 18
- C. 32
- D. 48
- E. 54

NOTE: The alternatives are overlapping because a cell that contains 18 chromosomes also contains 12; a cell that contains 32 also contains 18 and 12; etc.

4. **Alternatives should be homogenous in content.** Alternatives that are heterogeneous in content can provide cues to student about the correct answer.

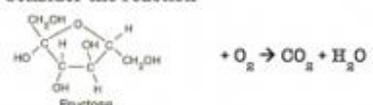
HETEROGENEOUS CONTENT

Which of the following is one of the ways that the membranes of winter wheat are able to remain fluid when it is extremely cold?

- A. by increasing the percentage of cholesterol molecules in the membrane
- B. by decreasing the percentage of unsaturated phospholipids in the membrane
- C. by decreasing the percentage of short-chain fatty acids in the phospholipids of the membrane
- D. by increasing the percentage of saturated phospholipids in the membrane

NOTE: Because option A focuses on a different type of molecule (cholesterol) than items B, C, and D, it can cue savvy test-takers to the correct answer.

5. **Alternatives should be free from clues about which response is correct.** Sophisticated test-takers are alert to inadvertent clues to the correct answer, such differences in grammar, length, formatting, and language choice in the alternatives. It's therefore important that alternatives
- have grammar consistent with the stem.
 - are parallel in form.
 - are similar in length.
 - use similar language (e.g., all unlike textbook language *or* all like textbook language).
6. **The alternatives “all of the above” and “none of the above” should not be used.** When “all of the above” is used as an answer, test-takers who can identify more than one alternative as correct can select the correct answer even if unsure about other alternative(s). When “none of the above” is used as an alternative, test-takers who can eliminate a single option can thereby eliminate a second option. In either case, students can use partial knowledge to arrive at a correct answer.
7. **The alternatives should be presented in a logical order** (e.g., alphabetical or numerical) to avoid a bias toward certain positions.

<p style="text-align: center;">LOGIC INTERNAL TO THE QUESTION</p> <p>Consider the reaction</p> <div style="text-align: center;">  <p style="text-align: center;">Fructose + O₂ → CO₂ + H₂O</p> </div> <p>In this reaction, which molecule is being oxidized?</p> <p>A. Fructose C. O₂ B. CO₂ D. H₂O</p>	<p style="text-align: center;">ALPHABETICAL ORDER</p> <p>Glucose diffuses slowly through artificial phospholipid bilayers. The cells lining the small intestine, however, rapidly move large quantities of glucose from the glucose-rich food into their glucose-poor cytoplasm. Using this information, which transport mechanism is most probably functioning in the intestinal cells?</p> <p>A. Active transport pumps B. Exocytosis C. Facilitated diffusion D. Phagocytosis E. Simple diffusion</p>
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8. **The number of alternatives can vary among items as long as all alternatives are plausible.** Plausible alternatives serve as functional distractors, which are those chosen by students that have not achieved the objective but ignored by students that have achieved the objective. There is little difference in difficulty, discrimination, and test score reliability among items containing two, three, and four distractors.

Constructing Stems (This information is derived from Brame, 2013)

1. **The stem should be meaningful by itself** and should present a definite problem. A stem that presents a definite problem allows a focus on the learning outcome. A stem that does not present a clear problem, however, may test students' ability to draw inferences from vague descriptions rather serving as a more direct test of students' achievement of the learning outcome.

<p style="text-align: center;">STEM IS NOT MEANINGFUL</p> <p>Which of the following is a true statement?</p> <p>A. Mitochondrial genomes are relatively constant in content (i.e., types of genes present). B. Mitochondrial genomes are relatively constant in organization. C. Mitochondrial genomes are relatively constant in size.</p>	<p style="text-align: center;">BETTER STEM</p> <p>What characteristic is relatively constant in mitochondrial genomes across species?</p> <p>A. Content (i.e., types of genes) B. Organization C. Size</p>
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2. **The stem should not contain irrelevant material**, which can decrease the reliability and the validity of the test scores (Haldyna and Downing 1989).

IRRELEVANT MATERIAL

Mitochondria evolved from free-living bacteria that could carry out oxidative phosphorylation. For this reason, they have circular genomes that reproduce independently of the nuclear genome. What characteristic is relatively constant in mitochondrial genomes across species?

- A. Content (i.e., types of genes)
- B. Organization
- C. Size

3. **The stem should be negatively stated only when significant learning outcomes require it.** Students often have difficulty understanding items with negative phrasing (Rodriguez 1997). If a significant learning outcome requires negative phrasing, such as identification of dangerous laboratory or clinical practices, the negative element should be emphasized with italics or capitalization.

NEGATIVE PHRASING

Which of the following is not true about mitochondria?

- A. They contain DNA.
- B. They make some of their own proteins.
- C. They are static.

NEGATIVE PHRASING

All of the following are true about mitochondria except

- A. They contain DNA.
- B. They make some of their own proteins.
- C. They are static.

BETTER USE OF NEGATIVE PHRASING

A water-type extinguisher is suitable for putting out a fire caused by burning all of the following except

- A. alcohol
- B. cotton
- C. paper
- D. wood

Source: Cheung, Derek and Bucat, Robert. How can we construct good multiple-choice items? Presented at the Science and Technology Education Conference, Hong Kong, June 20-21, 2002.

4. **The stem should be a question or a partial sentence.** A question stem is preferable because it allows the student to focus on answering the question rather than holding the partial sentence in working memory and sequentially completing it with each alternative (Statman 1988). The cognitive load is increased when the stem is constructed with an initial or interior blank, so this construction should be avoided.

INTERIOR BLANK	BETTER
<p>In addition to the nucleus, _____ are organelles that contain DNA.</p> <p>A. Golgi bodies B. Mitochondria and chloroplasts C. Ribosomes</p>	<p>In addition to the nucleus, which organelles contain DNA?</p> <p>A. Golgi bodies B. Mitochondria and chloroplasts C. Ribosomes</p>

Additional Guidelines Alternatives (This information is derived from Brame, 2013)

1. **Avoid complex multiple choice items**, in which some or all of the alternatives consist of different combinations of options. As with “all of the above” answers, a sophisticated test-taker can use partial knowledge to achieve a correct answer.

COMPLEX MULTIPLE CHOICE
<p>Who received a Nobel Prize for discovering the structure of DNA?</p> <p>A. Francis Crick B. James Watson C. Rosalind Franklin D. A and B E. B and C F. A and C</p>

2. **Keep the specific content of items independent of one another.** Savvy test-takers can use information in one question to answer another question, reducing the validity of the test.

Examples of Multiple Choice Questions that Assess Higher-Order Thinking Skills

Below are examples of questions that are transformed from knowledge questions to higher order questions.

Real-world scenarios (The Learning Coach, n.d.)

Example 1:

- **Before:** What is the first concern of an emergency worker?
- **After:** You arrive at the scene of an accident where people are panicked and yelling. Three people appear to be injured. What action will you take first?

Example 2:

- **Before:** Which of the following are measures of morbidity? (check all that apply)
- **After:** A researcher is interested in recording the number of individuals in a particular geographic region who have a common cold at some point during the month of February 2001. Which of the following measures of morbidity would be most appropriate in answering this question?

Example 3:

- **Before:** What symbol does a formula always start with in Excel?
- **After:** If you want to total the first ten data cells in column b, which one of the following formulas should you use?

Analysis of visuals (The Learning Coach, n.d.)

Example 4:

- **Before:** What are the components of a computer's video system? (Select all that apply.)
- **After:** Using the repair flowchart shown here, what should you check if the monitor stops working?

Example 5:

- **Before:** Choose the best definition of rate card.
- **After:** Using the rate card, what is the best time for a customer in the United States to make an international call to Brazil?

Example 6:

- **Before:** Which country has the largest population?
- **After:** What does this graph predict about world population in the year 2020?

Example 7:

- **Before:** Select the best definition of active listening.
- **After:** Which video best demonstrates active listening during a call with an irate customer?

The Answer Plus the Reason Why (The Learning Coach, n.d.)

Example 8:

- **Before:** What are three signs of edema?
- **After:** A patient entered the hospital with edema of both lower extremities. What action should the nurse take and why?

Example 9:

- **Before:** Select the most effective tone for writing technical documentation.
- **After:** Select the paragraph and reasoning that best demonstrate how to start a technical document.

Example 10:

- **Before:** Name three qualities of effective entrepreneurs.
- **After:** Review the financials of these three startup companies. Which one would you invest in and why?

Item Flipping (Scully, 2017)

According to Piaget's theory of cognitive development, what is accommodation?

- A. The ability to think logically
- B. The diminishing of a response to frequently repeated stimulus
- C. Altering one's existing schemas as a result of new information

D. An inability to understand perspectives besides one's own

To

After Sarah learned that penguins can't fly, she had to modify her existing concept of birds. This best illustrates the process of:

- A. Accommodation*
- B. Conservation
- C. Habituation
- D. Egocentrism

Multi-level thinking or Tapping Multiple Neurons (Scully, 2017)

Tim's second grade teacher is concerned because of the following observations about Tim's behavior in class:

- Withdraws from peers on the playground and during group work
- Often confuses syllables in words (ex: says mazagine instead of magazine)
- Often confuses b and d, p and q, etc. when writing or recognizing letters
- Loses his place when reading

The teacher has arranged a meeting with Tim's mother to discuss these concerns.

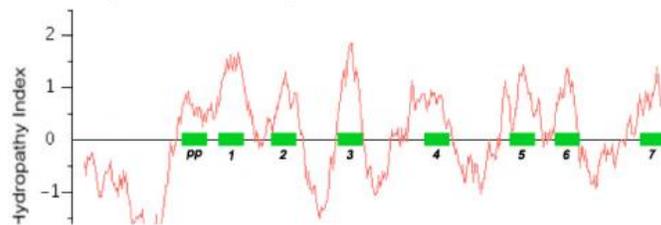
Which of the following statements is best for the teacher to say to Tim's mother?

- A. Tim needs extra practice reading and writing problematic letters and words at home at least 30 minutes per day.
- B. Please discuss the importance of schoolwork to Tim so that he will increase his efforts in classwork.
- C. These are possible symptoms of dyslexia so I would like to refer him to a specialist for diagnosis.
- D. Please adjust Tim's diet because he is most likely showing symptoms of ADHD due to food allergies.

TESTING HIGHER ORDER THINKING

A hydropathy plot for the protein AmGr2 is shown below. This protein has a signal peptide at its amino-terminus, and its hydrophobicity is shown in the hydropathy plot. Regions of the protein with a hydropathy index greater than zero are considered hydrophobic; regions with a hydropathy index less than zero are considered hydrophilic. Based on this information, what kind of protein do you think AmGr2 is?

- A. Integral membrane protein with a single transmembrane domain
- B. Cytosolic protein
- C. Multi-pass integral membrane protein with multiple transmembrane domains
- D. Lipid-anchored membrane protein
- E. Peripheral membrane protein



NOTE: This item tests higher order thinking skills because it requires that test-takers be able to **interpret** the plot and **apply** biochemical principles to choose the best answer.

Figure Source: Kent, Lauren B. and Robertson, Hugh M. Evolution of sugar receptors in insects. *BMC Evolutionary Biology* 9: 41, 2009

(This information is derived from Brame, 2013)

TESTING HIGHER ORDER THINKING

The nurse is making a home visit to a 75-y-o male client who has had Parkinson's disease for the past five years. Which finding has the greatest implication for this patient's care?

- A. The client's wife tells the nurse that the grandchildren have not been to visit for over a month.
- B. The nurse notes that there are numerous throw rugs throughout the client's home.
- C. The client has a towel wrapped around his neck that the wife uses to wipe her husband's face.
- D. The client is sitting in an armchair, and the nurse notes that he is gripping the arms of the chair.

NOTE: This item tests higher order thinking skills because it requires that test-takers be able to **apply** multilogical thinking and a high level of discrimination to choose the best answer.

Source: Morrison, Susan and Free, Kathleen Walsh. Writing multiple-choice test items that promote and measure critical thinking. *Journal of Nursing Education* 40: 17-24, 2001.

(This information is derived from Brame, 2013.)

Other Resources

Here are links to additional resources:

Martin, C. (2019, November 19). [Raising the bar: Creating multiple-choice questions to assess higher-order thinking skills](https://uws0-my.sharepoint.com/:p:/g/personal/cmartin_uws_edu/EXa3KcqDWPRGhy9MqswioKIBwt0EXMm5AhOoM4suE3RKKw?e=regSw1). Retrieved from https://uws0-my.sharepoint.com/:p:/g/personal/cmartin_uws_edu/EXa3KcqDWPRGhy9MqswioKIBwt0EXMm5AhOoM4suE3RKKw?e=regSw1

Martin, C. (2021, July 21). [How to write effective test questions](https://uws0-my.sharepoint.com/:p:/g/personal/cmartin_uws_edu/ESNRAetjm_VOksZFMXhvPHkBCHoHCdjlj3aFEU5AkY7muw?e=nkrjli). Retrieved from https://uws0-my.sharepoint.com/:p:/g/personal/cmartin_uws_edu/ESNRAetjm_VOksZFMXhvPHkBCHoHCdjlj3aFEU5AkY7muw?e=nkrjli

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- Brame, C. (2013) [Writing good multiple choice test questions](https://cft.vanderbilt.edu/guides-sub-pages/writing-good-multiple-choice-test-questions/). Retrieved August 13, 2021 from <https://cft.vanderbilt.edu/guides-sub-pages/writing-good-multiple-choice-test-questions/>
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- WSU Online (2021). Test Construction. Retrieved from <https://weber.instructure.com/courses/351442>
- Zimmerman, D. M. (2016). Writing good multiple-choice exams. Retrieved from <https://facultyinnovate.utexas.edu/sites/default/files/writing-good-multiple-choice-exams-fic-120116.pdf>