

Developing Multiple Choice Tests That Assess Higher Order Thinking Skills

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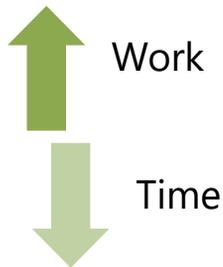
Chat

What is your greatest challenge with using multiple choice tests as a component of your teaching and/or assessment?



Reality...

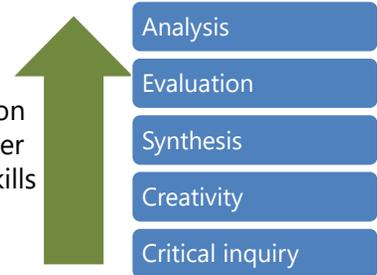
On average, faculty work 61 hours per week with 40% of time devoted to teaching



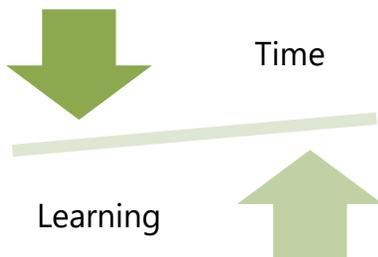
Source: Ziker, J. (2014). The long, lonely job of homo academicus. *The Blue Review*, Boise State University. Available: <https://theblureview.org/faculty-time-allocation/>

Compounding the issue...

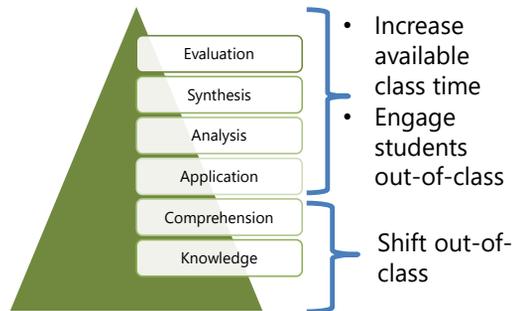
Emphasis on higher order thinking skills



The challenge...



The goal...



Learning is not the result of what the instructor does during class, but what the student does outside of class.

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~McKeachie, 1999

Value of Multiple-Choice

- Versatile**
 - Assess range of learning objectives
 - Permit wide sampling of content domain
 - Administered in range of formats
- Consistent**
 - Objective nature limits bias in scoring
 - Not influenced by students' writing skills
 - Amenable to repeated practice
- Efficient**
 - Easy to administer
 - Efficient to score
 - Quick feedback for students and faculty
 - Often available as a supplemental resource

Limitations of Multiple-Choice

- Value Dependent on Quality**
 - Quality items are difficult and time consuming to develop
 - Tendency for items to focus on low level learning objectives
- Lack of Precision**
 - Assessment results may be influenced by students' testing ability
 - May overestimate learning due to guessing
 - Does not measure the ability to organize and express ideas

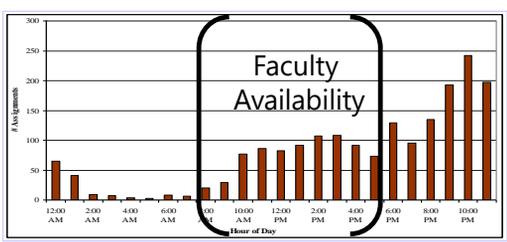
Pedagogical Strategies

- Drill-and-Practice**
 - Repeated exposure when memorization and accuracy is important
- Test Knowledge**
 - Gauge conceptual understanding in relation to learning objectives
- Promote Engagement**
 - Guide and monitor exposure to instructional resources
- Individualized Feedback**
 - Test and correct understanding

Automating Engagement



Meeting Students' Schedule



Student Activity

Mastery Learning

Repeated exposure

Unlimited attempts

Individualized pace

Self-reflection

Time on task

Mastery learning leads to:

- Enhanced retention
- Enhanced, self-paced instruction
- Enhanced understanding

Individualized Feedback

Immediate feedback:

- *Verification*
 - Right or wrong
- *Elaboration*
 - Feedback on selected response

Increased motivation

Increased encoding accuracy

Increased metacognitive understanding

Assess existing knowledge

Guidance in how-to-learn

Pedagogical Impact

Before

- Enhance preparation for class
- Direct attention on key concepts
- Adapt classroom activities

During

- Active responding during lectures
- Review games
- Classroom assessment techniques

After

- Mastery quizzes
- Knowledge check
- Review key points
- Correct conceptual errors

Helpful technologies...

Start with:

- LMS assessment features
- Textbook supplements or websites
- University-supported clicker technology

Supplemental options:

- Polling applications:
 - Poll Everywhere
- Quiz games:
 - ClassMarker
 - ClassTools
 - Hot Potatoes
 - ProProfs Quiz School
 - Quiz Revolution
 - Edgames
 - What2Learn

Creating Items: General Guidelines

Focus on learning objective

- All items must match relevant instructional objectives
- Target significant facts or concepts, not trivial questions or details

Be clear

- Use clear, precise and simple language
- Only include language that is necessary to present the problem or question

What students learn depends as much on your tests as your teaching.

~McKeachie, 1999

Focus on Learning Objectives

Taxonomy Level	Verbs
Evaluation	critique, summarize, explain, judge, interpret, predict, conclude, appraise
Synthesis	organize, design, combine, develop, generate, relate, arrange, estimate
Analysis	compare, categorize, diagram, infer, model, contrast, select, breakdown
Application	solve, apply, choose, compute, modify, relate, solve, prepare, demonstrate
Comprehension	differentiate, match, describe, explain, recognize, classify, discuss
Knowledge	identify, label, define, list, match, name, state, select

Targeting Higher Order Learning

- One clear answer
 - Select the "best" answer directions are well suited for items dealing with interpretation, understanding, or inference
- Focus on analysis
 - Utilize terminology that promotes the assessment of higher order learning objectives a
 - Ask "how," "why," or "which" as opposed to "who," "when," or "where"
- Require thinking not memory
 - Utilize analogies to go beyond simple recognition to identify the relationship between two ideas in various contexts
- Provide context
 - Provide a hypothetical premise and require students to select from various consequences.
 - Present a problem and possible solution; require students to evaluate the solution based upon criteria provided and select choices that align with evaluation

Examples

The following examples are taken from:

- <https://www.khanacademy.org/test-prep/mcat/social-sciences-practice>

Example

Pavlov's dogs are perhaps the most famous case of classical conditioning. In his experiments Pavlov paired the ringing of a bell with presenting his dogs with food, and that he measured the amount of saliva produced by ringing the bell alone. By taking these measurements before and after the pairing, it was shown how a stimulus that normally has no response could be paired with a stimulus that does.

The principles of classical conditioning extend far beyond carnes and saliva; they can even be used to condition our immune system as a means of treating autoimmune diseases. Lupus is one such autoimmune disease, and treatment requires the suppression of a person's immune system to protect their tissues and organs from being targeted by their own white blood cells. Cyclophosphamide is a chemotherapeutic drug (killed only or immunosuppressant) that is considered to be the standard treatment for lupus; however, like many chemotherapies, the side effects of the drug can be quite severe.

In 1992 a team of researchers showed that the human immune system can be classically conditioned, such that an 11 year old girl suffering from lupus was able to have significant reduction of her symptoms without any need of immunosuppressant drugs. This provided an opportunity to treat their patient's disease while avoiding the deleterious side effects of cyclophosphamide.

For their experiment, the researchers utilized a "Compound CS" which was a liquid that tasted of cod liver oil and had the smell of a rose. They paired Compound CS with the cyclophosphamide treatments on 6 occasions for a year. Every other month of treatment, the researchers did not administer the cyclophosphamide, and simply gave their patient compound CS instead. Despite administering the immunosuppressant drug at half the normal dose, the 11 year old patient still evidenced immunosuppression and continued to do well after a 5 year followup.

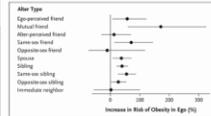
"Claxton (Dang) DM, Goodman AD, Scribner RB, Mattson DR, Pelise M, Cohen N, Alder R. J. Conditioning of cyclophosphamide-induced leukopenia in humans. *Neuropharmacology Clin Neurosci*. 1998;39(2):194-201. Cohen N, Alder R. Immunomodulation by classical conditioning. *Acta Biochem Psychopharmacol*. 1988;44:939-942.

If cyclophosphamide is a standard drug treatment for lupus, why should a physician consider using Compound CS and classically conditioning his or her patient?

- Classical conditioning could be used in cases where the drug is ineffective in treating lupus
- Compound CS could be helpful when a drug's side effects are not tolerable
- Compound CS could be helpful in ending the use of cyclophosphamide to treat lupus
- Classical conditioning could be used when a patient is not compliant with treatment

Example

Figure 1: Percentage increase in obesity risk for an ego based upon his/her relationship with an alter. The dependent variable in each model is the obesity of the ego. Independent variables include a time lagged measurement of the ego's obesity, the obesity of the alter, a time lagged measurement of the alter's obesity, the ego's sex, age, and education. Mean effect sizes (solid black dot) and 95% confidence intervals (line) are shown.



In later studies on the relationship between social networks and health behaviors, one of the researchers further found that existing social ties (specifically close friendships) are more likely to dissolve between people with poor health than are those including weaker ties that are immutuable such as height and personality, and traits that are malleable such as BMI, blood pressure, etc. In particular, those with similar BMIs are less likely to dissolve existing ties and more likely to form ties. Another study demonstrated that food choices also were made in accordance to social networks. In particular, spouses showed the strongest influence in food consumption behaviors, controlling for social contextual factors. Across all seven behaviors, siblings, friends, eating partners that were most likely to be altered were "alcohol and snacks."

Source: Adapted from Christakis, N. A., & Fowler, J.H. (2007). The Spread of Obesity in a Large Social Network over 32 Years. *The New England Journal of Medicine*, 357(16), 370-379. Christakis, N. A. (2011). Longitudinal analysis of large social networks: Estimating the effect of health traits or changes in health on ties. *Statistics in Medicine*. 30(18), 350-364. Pappalardo, M.A., Jacques, P.F., & Christakis, N.A. (2015). Social Networks Concoctance in Food Choice Among Spouses, Friends, and Siblings. *American Journal of Public Health*, 105(10), 2170-2177.

- Which conclusion is best supported by the findings in Figure 1?
- Friends of opposite genders only marginally increased the likelihood of obesity for the ego.
 - Obese persons do not seem to selectively form social ties only with other obese persons.
 - There is almost no effect on the ego when someone in the same geographic proximity gained weight.
 - If a mutual friend lived far away gained weight, the ego would not be more likely to gain weight.

Context-Rich Multiple Choice Items

- Interpret charts, tables or graphs
- Video analysis
- Multimedia response options
- Respond to scenarios, vignettes or case studies
- Comparative analysis
- Integration of multiple information sources

Chat

Reflecting on our discussion today, how might you use multiple choice assessments in your teaching to more effectively support higher order student learning?



Questions and Ideas



Innovative Educators

Supporting Academic & Professional Growth In Higher Ed



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