Writing Effective Quiz Questions

Introduction

Online quizzes can be an efficient tool for assessing your students learning. Writing effective questions, however, is a learned art that requires thoughtful consideration of several factors.

Two main concerns when it comes to writing effective quiz questions are **validity** and **cognitive load** (Parkes & Zimmaro, 2016). A quiz and each individual question are **valid** when they measure what they aim to measure and not some other extraneous variable. **Cognitive load** is related to validity: if students have to spend too much time and effort understanding how the quiz is organised, and what they are being asked to do, then this limits their ability to demonstrate their knowledge and understanding of concepts, which is what we really want to assess.

In this *Guide* we explore ways we can take advantage of the convenience offered by online quizzes, while at the same time maintaining rigour in the assessment of our students' learning. Firstly, we discuss validity and how to ensure that we are indeed assessing what we should. We then suggest strategies for writing effective multiple choice questions (MCQs) and present suggestions for presenting quiz questions online to ensure that cognitive load is minimised and validity is upheld.

What are we assessing?

The first step in quiz writing is to **identify the learning outcomes** that will be assessed. Start by revisiting your course objectives and look at the verbs through which they are expressed: are students expected to describe, apply, analyse, or evaluate? These verbs indicate different levels of 'knowledge' and should guide you in writing your questions.

There are several taxonomies of learning that show levels of knowledge and the types of actions that are typically associated with them. Among the most popular cognitive learning taxonomies are Bloom's (1956), Krathwohl's (2002), and Bigg's SOLO.) Table 1 provides examples of action verbs that can be used to assess learning at each level of the three taxonomies:

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Table 1: Levels of 'knowledge', question examples and types

Taxonomy level: **Bloom's = (B)** **Krathwohl = (K)** **Biggs' SOLO = (S)**	**What's involved**	**Example questions**	**What 'solving a problem' at this level entails**	**Example Moodle question types**
Knowledge (B) **Remember (K)** **Unistructural (S)**	Recognising and recalling Retrieving knowledge in the same format it was originally accessed.	• List the steps in process X (list of steps given in textbook) • Who led the battle of [place] in [year]? • Label the components of [machine]	Answering the quiz question involves retrieving information (i.e. a solution) that students have memorised. Answering correctly does not require understanding the problem. Students have seen the exact same problem previously.	Drag-and-drop; Matching; Missing words; Multiple-choice question (MCQ)
Comprehension (B) **Understand (K)** **Multistructural (S)**	Explaining, summarising, estimating, predicting effects or consequence, translating e.g. data to words, providing examples.	• Interpret charts or graphs (i.e. 'read' a chart) • Write mathematical formula for word problem (e.g. write as a formula: "The difference between A and B is 30") • Explain procedure • Give examples of X • Paraphrase	Students restate the problem, e.g. by paraphrasing it or translating it using mathematical notation. Students verbally describe a table or chart displaying problem data. The problem may be one that students have previously encountered or a very similar one. Does not require making connections across content areas or recognising broader implications.	Drag-and-drop; Matching; Missing words; MCQ; Short answer; Calculated
Application (B) **Apply (K)** **Multistructural (S)**	Using learned material in a new situation where the parameters are specified (i.e. students don't have to analyse the situation). Executing, implementing.	• Apply concepts, principles, laws or formulae to new situation, e.g. "If the train travels at 100 k/h, how long will it take to reach a place 200 k away?" • Demonstrate the correct procedure to follow in a given context	Students implement a tried-and-tested approach to solve an unseen but familiar, simple problem. The parameters around the problem (i.e. constraints, contextual information, premises) are clearly described to students. There is one 'correct' or 'best' approach to solve the problem; students do not	Drag-and-drop; Matching; Missing words; MCQ; Short answer; Calculated

			need to evaluate alternatives.	
Analysis (B) **Analyze (K)** **Relational (S)**	Identifying components, relationships between parts, organizational principles or structure. Recognising assumptions, misconceptions, facts v inferences. Differentiating, organising.	• Compare, contrast, differentiate between X and Y • Describe the structure of [text] • Identify the main components of [object, system] • Identify the relationship between X and Y	Students analyse an unseen problem to identify its constraints and requirements. For example, they may break a complex problem into steps or parts that can be tackled by using tried-and-tested methods.	Drag-and-drop; Missing words; MCQ; Short answer; Essay
Evaluation (B) **Evaluate (K)** **Relational (S)**	Critiquing, judging the value of X for a specific purpose and with reference to specified criteria. Criteria can be given or created by students.	• Critique X and justify your views • Appraise, evaluate X according to criteria Y and Z • Given context X, is solution Y or Z more effective/appropriate ? Why?	Given a complex problem, students consider a variety of solutions, identify what they think is the best one, and justify their choice by constructing a convincing argument and/or by providing supporting evidence.	MCQ; Essay; Short answer
Synthesis (B) **Create (K)** **Extended Abstract (S)**	Integrating ideas, parts to form a new whole. Creating new solutions, text, artwork, etc. Generating, planning.	• What is the missing piece in system X? • What is the bigger picture? What does X really mean? • What conclusion can we draw by putting the parts together? • Solve a problem by integrating learning from different areas. • Create new story, design, system, etc. • Devising ways of testing a hypothesis.	Students are given (or draw on) a variety of data points and information regarding a complex problem. Students integrate this information to produce or recommend a solution. Students generate a new method or approach for solving the problem.	MCQ; Essay (possibly in combination with other question types in a multi-part question)

It is important to note that every subsequent level in a learning taxonomy implies all preceding ones. For example, to be able to synthesise, students must be able to apply; to be able to apply, they must be able to comprehend, and so forth.

One way of shifting a question toward higher-order thinking is to **ask 'why' or 'how' questions**, rather than 'what'. Using **scenarios, vignettes, graphs, tables or graphics** as contexts for sets of questions can be very effective; for example, a case study can be followed by MCQs that require students to infer, interpret, apply, analyse, synthesise, etc. Alternatively, a set of closed questions could be followed by one open question that asks students to explain or justify their answers.

Online quizzes are especially suited for this type of input, as scenarios can be presented using multimedia or software applications that recreate the authenticity of professional settings (Cramp et al. 2019). If you write questions that involve higher-order thinking, however, keep in mind that students will need more time to form a response, compared to quizzes that involve simple recall or application.

Writing effective MCQs

MCQs tend to be among the most popular format of quiz questions. They offer the convenience of automated marking, but as we have seen they can be written to assess higher-order thinking. Therefore, MCQs can be an effective and efficient way of assessing learning outcomes. MCQs have a two-part structure:

- A ***stem***, which can be a question or a statement and
- A set of **options** that answer or complete the stem. One of these options is the ***key,*** **or the correct option**; the other options are called *distractors.*

Writing effective MCQs can be challenging. There are many resources that list the do's and don'ts of MCQ writing, some of which are listed in this guide. The two principles of assessment, validity and cognitive load that were introduced at the outset of this guide provide a helpful framework for MCQ writing, as discussed in Jay Parks and Dawn Zimmaro's book, *Learning and Assessing with Multiple-Choice Questions in College Classrooms*:

1. **Language should be only as verbose and/or complex as it needs to be.** If a learning objective is that students will be able to discriminate between relevant and irrelevant information, then having information that students must 'weed out' would be a valid choice. Similarly, if students must be able to use professional terms, then having these terms in the question would support assessment validity. What we want to avoid, however, is if students are unable to demonstrate their knowledge because of the way the question was worded. For example, they didn't understand the language used in the question, or the question was so long that they got lost in it. As a rule of thumb, the stem should only include information that students need in order to select the correct option.
2. **Avoid negative statements if possible** as they are cognitively more demanding than positive statements and can affect validity. If a student selects an incorrect answer it could very well be because they didn't notice the negative form. If negatives must be used, then students' attention should be drawn to them (e.g. using bold typeface or adding a warning).
3. **The *key* must be 'unambiguously correct' and 'represent some consensus of the field'** (Parkes & Zimmaro, 2016, p. 26). We must be able to offer evidence (e.g. from the textbook or relevant resources from our discipline) that it is indeed correct, and not just what we *think* is correct. However, it is possible to have keys that are the *best option* rather than the only one that's *correct*. In the *best option* approach, the distractors may not be completely incorrect, but they are not as effective as the best option. If this approach is used, students should be made aware of it.
4. **Direct questions are best** in terms of minimizing cognitive load and are therefore preferred. **Incomplete statements** are acceptable, but they work best when the gap is at the end of the sentence rather than in the middle, as the gap in the middle is cognitively more demanding. If, however, having the gap at the end of the stem causes a lot of

repetition in the options, then it's best to have a gap in the middle and eliminate the repetition.

5. **The number of options should be between 3 and 5.** If we want MCQs to be valid, the distractors must be plausible, i.e. students who haven't studied the material properly must think a distractor could indeed be correct. If we cannot find more than two plausible distractors, it's best to keep to 3 options (one key, two distractors) rather than creating an extra distractor that no sensible test-taker would think of as correct.
6. **Avoid using 'all of the above' or 'none of the above'**. These options introduce threats to validity in different ways; they make it easier for students to guess the correct answer and do not truly test learning objectives.
7. **Avoid other forms of 'cueing', e.g. sentence length, sequencing, or category of options.** The key often contains more detail and therefore tends to be longer. If students identify this as a pattern, they will be able to guess the correct answers without necessarily knowing the content. Similarly, quiz writers tend to avoid placing the key as first or last option. The Moodle quiz tool can be set to randomize the order of the options, so that this issue can be avoided. Finally, if one of the distractors is in a different category group (e.g. a feline where all other options are canines), then this is a clear cue that there is something special about it.

You can find annotated examples of well and poorly written MCQs, as well as examples of how MCQs can be used to assess higher-order thinking, in the following resources:

- Resource - Melbourne CHSE Guide on Multiple-Choice Questions
- Article - Scully D 2017, Constructing Multiple-Choice Items to Measure Higher-Order Thinking, Practical *Assessment, Research, and Evaluation*, vol. 22, no. 4.
- Resource - Wiley Writing Quiz Questions

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Presenting quiz questions online

Once you have decided on the content and form of your quiz questions, the next step is thinking about how questions are going to be organised and displayed on the screen. Students interact with online quizzes in a fundamentally different way to paper-based ones (Macedo-Rouet et al. 2009), which must be considered to ensure that cognitive load is minimised and validity is upheld. Our goal is to eliminate extraneous content, logically and aesthetically format content, and focus student's attention with visual signals (Gillmor, Poggio, & Embretson 2015). But what do these strategies look like in practice? Let's consider a couple of common examples.

In quizzes that contain sets of questions relating to a **scenario** or that require students to access a formula sheet or similar information source, consider providing this information in advance so that students can download it before the quiz opens or at the start of the quiz. This way, students can have documents side-by-side on the computer screen or have a printout. This reduces the volume of information that needs to be in their working memory, thus increasing their capacity to process the question/answer.

When drafting a question that involves a significant amount of context, also consider **visually separating out the context from the question**, such that the question is more obvious (i.e. stands out) to students. If the question asks students to demonstrate more than one thing (e.g. list two factors, describe their importance and provide your underlying rationale) consider structuring this is a list rather than a sentence, such that the deliverables can be gleaned at a glance.

If your quiz contains a collection of related questions in a multi-part set, all questions should be **visible on the screen together**. This enables students to see their mutual connections and enables you to make explicit links between questions. On the other hand, when questions are not related to one another, **displaying one question at a time** helps students focus without distractions.

Be sure to communicate to students the **marking allocation for sub questions** and alter the size of the text field (for essay questions) to guide the length and coverage of their response. In addition, ensure that you don't over rely on text formatting to draw student attention. Use one option only e.g. bold and use it consistently across all questions.

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Conclusion

Well-designed online quizzes can be very effective in supporting both teaching and learning. Ensuring that core assessment principles are considered is paramount; validity and cognitive load are especially relevant to quiz writing and can guide us in this process. In a separate *Online Teaching and Learning Guide,* we will look at evaluating existing quizzes to ensure that these principles are upheld and to identify any changes that might be required.

If you would like to ask online teaching and learning questions related to your course, you can look through our FAQs, write to TIU@unisa.edu.au, have an online consultation with a member of the TIU or complete the online modules as part of Introduction to Engaging Learners Online.

Further Resources from the TIU

- learn**online** help - Overview of Quizzes
- learn**online** help - Online Exams
- Resource - Hints and tips for writing multiple choice questions
- Online T&L Guide - Peer-Reviewing your Online Exam
- Online T&L Guide - Planning online exams using the quiz tool to minimize plagiarism (and promote learning)
- TIU website - Preparing for Online Exams

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