CTE Resource Guide: Checking Students' Understanding Through Quizzes/Exams

The Centre for Teaching Excellence (CTE) has put together this document to assist our SMU instructors when crafting quizzes/exams. The following table contains several question types found in eLearn. These are commonly used by our SMU instructors to check for students' understanding. Besides containing evidence of the impact of each question type on student learning outcomes, you can also find CTE's recommendations when crafting and assessing using the various types of questions. Please direct all queries regarding this document or guidelines on crafting effective quizz/exam questions to **cte@smu.edu.sg**.

Question Type	Evidence of Impact on Student Learning Outcomes	Key Recommendations on Crafting/Using it Effectively
MCQ (MCQ) For objective testing so as to eliminate ambiguity in marking. A MCQ usually has one (or a few) definite answers that are given as choices for the students to select. For instructors looking for an efficient and time-saving ways to assess large number of students. Image taken from http://theelearningcoach.com/elearning_design/rules-for-multiple-choice-questions/	There are limited number of published experimental studies on examining the impact of MCQs for improving student learning. There are a few reported studies that compared MCQs with other question formats (short-answer, essay). Positive findings were found in two such studies. For instance, Funk and Dickson (2011) found that students performed significantly better on items presented in MCQs as compared to identical questions presented in short-answer format. In another study, McDermott and colleagues (2014) found that frequent classroom quizzing using MCQs with feedback , improved student learning and retention.	**When crafting MCQs:** ● Ensure that the question stem (1) is **grammatically correct**; (2) should not contain **irrelevant material,** making it ambiguous; and (3) **avoid double negatives** – For example, this may confuse students: *"Which of the following comments would **NOT** be **unwelcome** in a work situation?"* Instead, flip it around and write it in the positive form: *"Which of the following comments are acceptable in a work situation?"* ● Ensure that the options are (1) **grammatically correct** and (2) of **similar lengths** to prevent students "guessing" through choosing the longest option ● Seek **critical comments** from your colleagues, or with other instructors teaching the same course to examine the MCQs you have crafted on their suitability for assessing students' knowledge **When assessing using MCQs:** ● Use **eLearn (M-C question type)** for MCQ assessments so that items can be randomised (reduced opportunity for students cheating) and grading automated, saving you time on manual marking; **feedback** can be also be made immediately available to students **Recommended resources:** 1. Funk, S., & Dickson, K. (2011). Multiple-Choice and Short-Answer Exam Performance in a College Classroom. *Teaching of Psychology, 38*(4), 273-277. 2. Osterlind, S., & SpringerLink. (1998). *Constructing Test Items Multiple-Choice, Constructed-Response, Performance, and Other Formats , Dordrecht : Springer Netherlands* (Second ed., Evaluation in Education and Human Services ; 47). (See Chapter 5 on constructing MCQs p.161 - 202; available as an e-Book in the SMU Libraries) 3. Shank, P., & American Society for Training Development. (2010). *Create Better MCQs , Alexandria VA : American Society for Training & Development*. (LKS Libraries Level 3: LB3060.32.M85 S42 2010)

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Two-Tier MCQ (TTMCQ) For assessing students' higher-order thinking skills in a quick and efficient manner. A TTMCQ is similar in format to a traditional MCQ but contains a second-tier of question associated with the main question. The first tier tests the content knowledge of the students, i.e. recall of knowledge, facts or concepts *(Remember /Understand)*. The second tier asks the reason for the response given in the first tier and goes beyond recall and facilitates HOT *(Apply/Analyse/Evaluate).*	TTMCQs have been used mainly in the healthcare and sciences disciplines. There is one study published in the Physics discipline where Çil (2015) engaged preservice science teachers (n = 97) in three different learning activities: TTMCQs, MCQs, or studying a lecture summary. The narratives of the participants before and after the learning activities were transcribed into a format of *flow maps* to assess their conceptual understanding of variables. They found that the mean scores of the post flow maps (on inferring and or explaining which showed thinking at the evaluation level) for the participants in the TTMCQ group were statistically higher as compared to the mean scores of the other two groups.	**When crafting TTMCQs:** ● Include **visual representation**s such as charts, figures and tables which require students' **analysis skills** to interpret the data ● Allow for **problem/evaluation**: a problem and its solution are usually presented. Students use their own judgement (based on given criteria in the question) and **critical thinking** to find the appropriate solution. Students can be asked to criticise, prove, defend or recommend ● Guidelines on crafting MCQs apply **When assessing using TTMCQs:** ● Conduct TTMCQ assessments in **eLearn** so that grading can be automated, saving you time on manual marking (though only options can be randomised but not questions); **feedback** can be made immediately available to students, facilitating their process of self-learning **Recommended resources:** 1. Çil, E. (2015). Effect of Two-tier Diagnostic Tests on Promoting Learners' Conceptual Understanding of Variables in Conducting Scientific Experiments. *Applied Measurement in Education*, *28*(4), 253-273. 2. Boston University School of Public Health (n.d.). Writing *MCQs that Demand Critical Thinking*. Retrieved from http://sphweb.bumc.bu.edu/otlt/teachingLibraries/Assessment/WritingMultiple.pdf.
Multiple True-False Question (MTFQ) /Multi-Select Question To detect the presence of students' correct and incorrect understandings. The question is similar to that of a MCQ, in that it contains a question stem and options, but	Two repeated measurement design studies in introductory biology courses reported on the extent to which MTFQs/Multi-Select Questions reveal students' thinking about correct and incorrect understandings. Hubbard, Potts and Couch (2017) did an experimental comparison of students' responses on MTFQs and free-response (essay questions) questions testing identical concepts. They found that MTFQs revealed a high prevalence of students with correct and incorrect	**When crafting MTFQs/Multi-Select Questions:** ● Include only **one main idea** in each option ● Avoid unfamiliar concepts and vocabulary and long string of statements ● Use statements which are unequivocally true or false ● **Paraphrase** statements from course materials so that recall alone will not get the correct response ● Try using in combination with other material, such as **graphs, maps, written material** as this combination allows for testing of higher order thinking levels **When assessing MTFQs/Multi-Select Questions:** ● Create MTFQs in **eLearn using the Multi-Select (M-S) question type** for automated grading

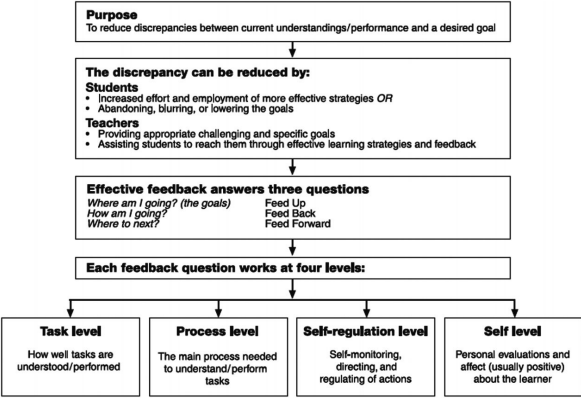| Question Type	Evidence of Impact on Student Learning Outcomes	Key Recommendations on Crafting/Using it Effectively
instead of having students selection the correct option(s), they must select true or false for each answer option.	conceptions of biology concepts. By contrast, free-response questions revealed a high prevalence of students with correct but unclear conceptions. In another study by Couch, Hubbard and Brassil (2018), they found that nearly half of the students who select the correct answer in the MCQs hold incorrect understandings of the other options. MTFQs on the other hand, were more accurate in detecting the presence of correct and incorrect understandings among students.	**Recommended resources:** 1. Couch, B. A., Hubbard, J. K., & Brassil, C. E. (2018). Multiple–True–False Questions Reveal the Limits of the Multiple–Choice Format for Detecting Students with Incomplete Understandings. *BioScience*, *68*(6), 455-463. 2. Hubbard, J. K., Potts, M. A., & Couch, B. A. (2017). How question types reveal student thinking: An experimental comparison of multiple-true-false and free-response formats. *CBE—Life Sciences Education*, *16*(2), ar26. 3. Pearson Education (n.d.). Writing Effective True-False Questions. Retrieved from *http://wps.prenhall.com/chet_stiggins_student_6e/213/54606/13979173.cw/content/index.html.*
Short Answer Question For assessing students' ability to recall information/basic knowledge about key terms and concepts. They can also be used for testing higher-order thinking skills such as analysis and evaluation. Students' responses are typically shorter compared to that for long answer questions.	There are several studies that compared students' performance (scores and retention of learning) on short answer and MCQs. The two studies described below found positive results with using short answer questions to improve student learning. Smith and Karpicke (2013) implemented retrieval practice by getting students to answer questions in short-answer, multiple-choice and hybrid (students recalled information using short-answer, then attempted MCQs) formats after reading educational text. Practising retrieval in all format conditions enhanced retention, relative to a study-only control condition. McDermott and colleagues (2014) found that frequent classroom quizzing using short answer questions/MCQs with feedback , improved student learning and retention. Students in their study scored significantly better on information that had been quizzed than that which was not quizzed on the exams	**When crafting short answer questions:** ● Word the question such that it is **not directly lifted** from course materials, and that a meaningful problem is presented ● Keep the question focused so that it is **clear** and has a **definitive answer/a narrow set of definite, clear-cut, and explicit** answers. For example, getting students to "illustrate a concept with an example"; "compare and contrast two or more concepts" **When assessing short answer questions:** ● Skim through all answers quickly so as to get an overview of the general level of performance and the range of students' responses before you start grading ● Identify responses that are excellent/good/fair/poor to refresh your memory of the standards by which you are grading and to ensure fairness over the period of time you spend grading **Recommended resources:** 1. Jordan, S., & Mitchell, T. (2009). e-Assessment for learning? The potential of short-answer free-text questions with tailored feedback. *British Journal of Educational Technology*, *40*(2), 371-385. 2. McDermott, K., Agarwal, P., D'Antonio, L., Roediger, H., McDaniel, M., & Brewer, Neil. (2014). Both Multiple-Choice and Short-Answer Quizzes Enhance Later Exam Performance in Middle and High School Classes. *Journal of Experimental Psychology: Applied, 20*(1), 3-21. 3. Smith, M., & Karpicke, J. (2013). Retrieval practice with short-answer, multiple-choice, and hybrid tests. *Memory, 22*(7), 1-19.

Question Type	Evidence of Impact on Student Learning Outcomes	Key Recommendations on Crafting/Using it Effectively
		4. Schwartz, M. (n.d.). Ryerson University - *Marking Essay and Short Answer questions.* Retrieved from https://www.ryerson.ca/content/dam/lt/resources/handouts/MarkingEssays.pdf.
Long Answer (Essay) Question For assessing students' abilities to apply, analyze and/or evaluate knowledge as they demonstrate their reasoning related to a topic.	Scouller (1998) compared students' learning approaches when tackling essay and MCQ questions. She found that poorer performance in the essays was associated with the employment of surface (focusing on recall and reproduction) learning approaches. Similarly, poorer performance in the MCQ exam context was associated with the employment of deep (focusing on meaning and understanding) learning approaches.	**When crafting long answer questions:** ● Question should be **clear and precise** so that students know how to respond ● Write out the answer to the question yourself and use it to revise the question ● Determine the **criteria** you will look for in assessing partial or full credit. Sample **rubrics** for assessing Long questions (essays) can be found here on CTE website under Resources **When assessing long answer questions:** ● **Skim through** all answers quickly so as to get an overview of the general level of performance and the range of students' responses before you start grading ● Identify responses that are **excellent/good/fair/poor** to refresh your memory of the standards by which you are grading and to ensure fairness over the period of time you spend grading ● Read the questions **without looking at the students' names** so as not to bias your grading by carrying over your perceptions about individual students ● Make **brief notes of the strengths/weaknesses** of each student's response so that you can refresh your memory in case your student wants to review the answer later. ● **Increase the reliability** of your grading by getting other instructors to grade the essays and do a comparison of the marks **Recommended resources:** 1. Reiner, C. M., Bothell, T. W., Sudweeks, R. R., & Wood, B. (2002). *Preparing Effective Essay Questions.* Retrieved from https://testing.byu.edu/handbooks/WritingEffectiveEssayQuestions.pdf. 2. Scouller, K. (1998). The influence of assessment method on students' learning approaches: Multiple choice question examination versus assignment essay. *Higher Education, 35*(4), 453-472. 3. Utah Valley University (n.d.). *Test Writing Tutorial on Essay Questions.* Retrieved from https://sites.google.com/site/testwritingtutorial/essay-questions.

Success Factors for Using Quizzes/Exams Effectively for Teaching and Learning

The following table details the factors/conditions that affect whether quizzes/exams improve student learning and the published evidence.

Factor/Condition	Literature evidence
Unannounced (i.e. pop) versus Announced quizzes	Positive findings were found as both unannounced and announced quizzes led to improvements in exam performance. In Azorlosa's (2011) study, announced, multiple-choice quizzes were administered to 1 of 2 sections of a Psychology of Learning class in each of 2 consecutive semesters. The quizzes were administered between the first and second exams which were also multiple-choice. He found that quizzes increased attendance and that students had a positive impression of the quizzes and their impact on studying and exam preparation through a student survey. Announced quizzes also significantly improved exam performance in both semesters. Kamuche (2007) found in his study of Quantitative Analysis students that the group with unannounced quizzes showed statistically better performance than the control group with announced quizzes. Unannounced quizzes were given on any day of every week whereas announced quizzes were given on Thursdays and Fridays of every week. His study suggests that that unannounced quizzes motivate students to read the material prior to the lectures. **References:** 1. Azorlosa, J. W. (2011). The effect of announced quizzes on exam performance: II. *Journal of Instructional Psychology, 38*, 3-7. 2. Kamuche, F. U. (2007). The effects of unannounced quizzes on student performance: further evidence. *College Teaching Methods & Styles Journal (CTMS), 3*(2), 21-6.
Quiz question type	Findings related to the impact of each question type on student learning is summarised in the table on pages 1-4.
Frequency of quizzing	Frequent testing over smaller amounts of information is shown to be beneficial to student learning. Batsell and colleagues (2017) conducted a quasi-experiment to examine the use of in-class, daily quizzes in Introductory Psychology. The control class studied assigned chapters from the textbook whereas the quiz class studied chapters and completed daily quizzes on those readings. They found that the quiz class scored significantly higher than the control class on the test questions which were the same as the quiz questions, and when they were new, related questions from the textbook. This study confirms the hypothesis that the increased frequency of quizzing (in this case, daily), promoted more engagement with the materials and more time studying, hence leading to better performance on achievement tests. Braun and Sellers (2012) found the use of daily motivational quizzes as effective in motivating non-accounting students in an introductory accounting course to: (1) prepare for class, (2) arrive to class on time, and (3) participate in meaningful class discussions and activities, based on students' perceptions. The daily quizzes were administered at the beginning of each class, and consisted of three conceptual questions based on pre-readings. Additionally, the authors also found that sections that utilised the daily

Factor/Condition	Literature evidence
	quizzes had lower course failure rate compared to those sections that did not have daily quizzes, differences were significant (t(347.3) = 2.823, *p*= 0.0025). Finally, the use of the daily quizzes had no adverse effect on course and instructor evaluations. **Reference:** 1. Batsell Jr, W. R., Perry, J. L., Hanley, E., & Hostetter, A. B. (2017). Ecological validity of the testing effect: The use of daily quizzes in introductory psychology. *Teaching of Psychology*, *44*(1), 18-23. 2. Braun, K. W., & Sellers, R. D. (2012). Using a "daily motivational quiz" to increase student preparation, attendance, and participation. *Issues in Accounting Education*, *27*(1), 267-279.
Formative versus Summative	Positive findings were reported in studies that examined the effect of formative or summative quizzes on exam performance. Khanna (2015) compared the impact of using no quizzes, graded quizzes, and ungraded quizzes on final exam scores of introductory psychology students. He found that ungraded pop-quizzes led to higher final exam performance than using graded pop-quizzes or using no quizzes. He recommend for instructors to use ungraded pop-quizzes in their courses to reap the benefits of test-enhanced learning without inducing test-anxiety. Hadsell (2009) administered online quizzes to introductory finance students. The quizzes contained questions based on materials from the course textbook and lecture notes, with levels of difficulty ranging from easy to moderately difficult. The online quizzes were not meant for evaluation (i.e. *formative*) but to help them in preparation for the exams. In the first group, students were told to complete complete each quiz in a specified 7-day interval after the content was covered. The second group was allowed to complete the quizzes at any time prior to the day before the first exam. He found that the group which completed weekly quizzes after the instructors covered the content, had statistically significant increase in performance on exams compared to the group which could complete the quizzes anytime they wanted. Johnson and Kiviniemi (2009) examined examined the effectiveness of compulsory (i.e. *summative*), mastery-based, weekly reading, online quizzes (6% of course final grade) in an introductory social psychology course as a means of improving exam and course performance. They found that students' performance on those exam questions covered by reading quizzes was significantly better than their performance on questions not covered by quizzes. **References:** 1. Hadsell, L. (2009). The effect of quiz timing on exam performance. *Journal of Education for Business*, *84*(3), 135-141. 2. Johnson, B. C., and Kiviniemi, M. T. (2009). The effect of online chapter quizzes on exam performance in an undergraduate social psychology course. *Teaching of Psychology, 36 (1), 33*-37. 3. Khanna, M. M. (2015). Ungraded pop quizzes: test-enhanced learning without all the anxiety. *Teaching of Psychology*, *42*(2), 174-178.
Quiz timing (i.e. before or after content coverage)	Over a course of 3 semesters, Marcell (2008) asked students in 1 section of introductory psychology to take time-limited, out-of-class, "open-book" online quizzes on daily readings and another section where students did not take quizzes during that course. He found that sections that received quizzes asked over twice as many questions at the beginning of class (M = 2.94, SD =1.65) as classes that did not receive quizzes (M = 1.20, SD = 1.22). In addition, students also reported that the quizzes required them to come to class better prepared. His study showed that brief, regularly-scheduled, out-of-class quizzes increased class participation and preparation among students. See also the study by Braun and Sellers (2012).

Factor/Condition	Literature evidence
	Reference: 1. Marcell, M. (2008). Effectiveness of regular online quizzing in increasing class participation and preparation. *International Journal for the Scholarship of Teaching and Learning*, *2*(1), 7.
In-class versus online quizzes	There is no study that examined the difference between administering the same quiz in class versus online. However, based on the studies included reviewed in this table, it was found that: ● In-class MCQ quizzes increased student attendance and exam performance (Azorlosa, 2011). ● The use of daily quizzes conducted in class at the beginning increased student punctuality, preparation for class and participation in class discussions (Braun and Sellers, 2012). ● Ungraded quizzes conducted at the end of each lesson in class led to significantly higher exam performance as compared to ungraded quizzes (Khanna, 2015). ● Students who took quizzes online that were based on daily readings reportedly showed an increase in the number of questions and comments made at the beginning of class, leading to better class participation Marcell, 2008). ● Students' performance on those exam questions covered by online, weekly quizzes was significantly better than their performance on questions not covered by quizzes (Johnson and Kiviniemi, 2009).
Feedback	Students' performance on quizzes can be enhanced with timely and targeted feedback on areas for improvement. Feedback is conceptualised as information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding. It is thought to have a powerful effect on student learning, especially when done well. Hattie and Timperley (2007) reviewed the evidence related to its impact on learning and achievement, and conceptualised a model of feedback that can enhance student learning: **Purpose** To reduce discrepancies between current understandings/performance and a desired goal **The discrepancy can be reduced by:** **Students** • Increased effort and employment of more effective strategies *OR* • Abandoning, blurring, or lowering the goals **Teachers** • Providing appropriate challenging and specific goals • Assisting students to reach them through effective learning strategies and feedback **Effective feedback answers three questions** Where am I going? (the goals) Feed Up How am I going? Feed Back Where to next? Feed Forward **Each feedback question works at four levels:** **Task level** — How well tasks are understood/performed **Process level** — The main process needed to understand/perform tasks **Self-regulation level** — Self-monitoring, directing, and regulating of actions **Self level** — Personal evaluations and affect (usually positive) about the learner **Reference:** 1. Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of educational research*, *77*(1), 81-112.