



THE DESIGN OF MULTIPLE CHOICE QUESTIONS FOR ASSESSMENT

WORKBOOK

The aim of this workbook is to provide a series of resources in considering the design and implementation of multiple choice questions for assessment.

The workbook is not exhaustive, but attempts to focus on a number of core issues and needs.

Key areas covered include:

- An Introduction to Assessment
- The Design of MCQs
- Developing MCQs in the Cognitive Domain

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AN INTRODUCTION TO ASSESSMENT

Some of the key purposes of assessment are; to demonstrate achievement of student learning; to give feedback on learning and teaching; and to assist students to self-regulate and critically evaluate their work (National Forum 2017)

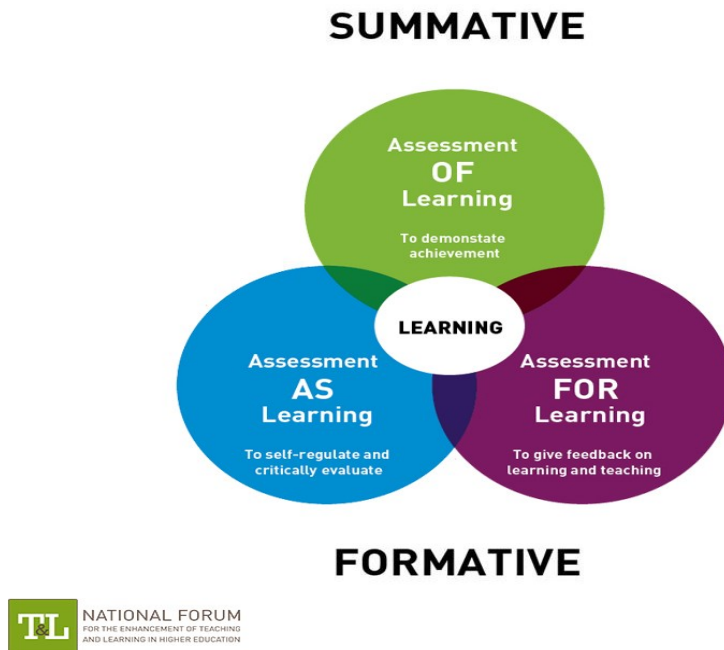


Figure 1: Three Purposes of Assessment (National Forum, 2017)¹

Formative Assessment

Assessment for learning

Is the assessment that provides feedback to learners in order to help them learn, and feedback to teachers to enable them to decide how a student's learning should be taken forward

Assessment as learning

Are the activities that support students to self-regulate and critically evaluate. Provides students with a way to critically evaluate their own and their peers' performance. It assists in planning for change in their learning (self-regulate)

Summative Assessment

Assessment of learning

Is the assessment which provides overall and finite evidence of the achievement of students and of what they know, understand and can do, by assigning a value (often quantitative) to what the student achieve

¹ <https://www.teachingandlearning.ie/resource-hub/student-success/assessment-of-for-as-learning/>

DESIGNING ASSESSMENTS²

Seven questions that lecturers might ask when designing an assignment are:

1. What are the outcomes to be assessed?
2. What are the capabilities/skills (implicit or explicit) in the outcomes?
3. Is the method of assessment chosen consonant with the outcomes and skills?
4. Is the method relatively efficient in terms of student time and staff time?
5. What alternatives are there? What are their advantages and disadvantages?
6. Does the specific assessment task match the outcomes and skills?
7. Are the marking schemes or criteria appropriate?

Common weaknesses to avoid
The tasks do not match the stated outcomes;
The criteria do not match the tasks or outcomes;
The criteria are not known to students;
Students do not understand the criteria;
Overuse of one mode of assessment e.g. written examinations, essays, or closed problems;
Overload of students and staff;
Insufficient time for students to do the assignments;
Too many assignments with the same deadline;
Insufficient time for staff to mark the assignments or examinations;
Absence of well-defined criteria so consistency is difficult to achieve;
Unduly specific criteria which create a straitjacket for students and make marking burdensome for lecturers;
Inadequate or superficial feedback provided to students;
Wide variations in marking between modules and assessors and within assessors (self-consistency);
Variations in assessment demands of different modules

² Brown G., Bull J., Pendlebury M (1997) *Assessing Student Learning in Higher Education*. London: Routledge.

THE DESIGN OF AN MCQ

Deconstructing an MCQ:

A multiple choice question (MCQ) is one in which the learner is invited to select one alternative (the correct one being the 'key') from a list of options (including the former and the 'distractors' – incorrect answers) in response to the question ('stem').

Thus a standard MCQ will consist of three core elements, the stem, the distractors and the key.

- How many economists does it take to change a lightbulb? ^[1]_{SEP}
1. They can't tell you unless you give them a lightbulb approximation to work on.
 2. They're projecting three for next year, but that's a conservative estimate.
 3. Nine. One to change the bulb, and eight to hold a seminar on how Nietzsche would have done it.
 4. One, but they'll spend three hours checking it for alignment and leaks.
 5. How many did it take this time last year?

*See footnote for identification of other distractors.

Query:

Is an MCQ the most appropriate means to test the desired outcome?

Are there viable alternatives... Short Answer Questions, Assertion-Reason questions, Multiple Response Questions, Essay, Portfolio, Performance etc

What are the benefits of the MCQ?

³ 1 = Physicists, 2= Economists, 3 = Philosophers, 4 = Engineers, 5= Statisticians

DECIDING WHEN TO USE AN MCQ

The use of MCQs is an attractive solution to the ever burgeoning assessment requirements, in that they may offer a fast and effective means to assess student learning... but what kind of learning...?

Advantages of MCQs:

- Easily marked, objective and reliable
- May measure different cognitive levels
- May offer diagnostic, formative or summative assessments
- May offer opportunity for feed forward (assessment for learning) and feedback
- The development of question banks may offer mid to long-term benefits to learners and faculty

Issues with MCQs:

- Developing good distractors is hard work
- Often difficult to determine why certain distractors are chosen i.e. no ability to garner feedback from student input/thought processes
- Often tend to test lower cognitive abilities (as these are easier to construct)
- They are difficult to write well and thus time consuming!

Assessment Comparison / Equivalence

Assessment	Learner Effort	Faculty Effort	
Descriptive Questions - 1 hour exam	c.9 hours preparation	<i>Writing the Q's</i> <i>Grading Task</i> <i>Grading time</i> <i>Validity</i>	Easy Difficult Long(!) Med-High
MCQs - 1 hour exam	c.9 hours preparation	<i>Writing the Q's</i> <i>Grading Task</i> <i>Grading time</i> <i>Validity</i>	Difficult Easy Short! High

THE KEY TO DESIGNING MCQS



Preparing MCQs:

- Write them as you prepare your session plans
- Relate them to the intended outcomes (one per question)
- Make use of common misconceptions and frequent questions
- Invert the approach and invite students to design MCQs
- Invite a colleague to evaluate the MCQs and eradicate any issues

Developing MCQs:

- Present practical or real-world scenarios e.g. journal articles that require interpretation, case studies that require analysis
- Make use of visuals that require a learner to analyse, evaluate or describe the application of 'x'
- Use data (charts, graphs figures etc) that require the learner to appraise or formulate an answer

Writing MCQs:

- Be concise and clear (always maintain the prime body of text in the question stem, not in the key and distractors)
- Ensure appropriate use of grammar i.e. do not unintentionally provide the answer via the stem
- Construct questions independently, avoid question series whereby information in one may provide context or even the answer to another
- Make sure each of the distractors is 'viable', provide uniformity in the proposed answers, and ensure no overlapping
- Avoid negative question constructs where possible, and the use of terms such as 'None of the above'

Tips for MCQs

- Where possible group together similarly formatted question types
- Provide a progression from simple (easy) to complex (hard)
- Remember to mix up the order of the answers
- Statistically provide a minimum of 5 answers, thereby pushing out the 'guess' factor! [assuming you are competent to provide four distractors for each question]

THE EDITING OF MCQS

This series of questions is a guide to enable one to review and amend your MCQs, and as such should be addressed post creation and ideally with a peer to hand...

Are the item/s addressed within the specified learning outcomes for the module / programme?
Only materials covered and identified should be assessed...

Are they written at the appropriate level?
Questions should not appear trivial, however they must not also seek knowledge beyond the scope required.

Are they written to assess the appropriate cognitive level?
Consider the design of questions to assess particular abilities and/or in differing situations.

Are the key and stem correct?
Indisputably?!?

Does the stem state the question?
The stem should ordinarily contain a complete statement of the question... leading to a knowledgeable learner anticipating the answer. If not, the question often requires revision and the presence of further distractors.

Is all the information in the stem necessary?
Edit and edit again, less is best, any additional information may be leading.

Are all of the distractors plausible?
Each distractor must appear possible to less knowledgeable learners. Post statistical analysis will determine less worthy distractors.

Are all of the distractors incorrect?
Indisputably?!?

Do any of the options overlap?
If the options are numerically based, it may be possible that a number of options are 'un-intentionally correct. It is less common in text based options, but none the less a probability – best avoided.

Do any of the options provide clues?
A common occurrence (unconsciously) is to provide a term in the key that appears in the stem, but not the other distractors. Alternatively a key is often written in a more precise form than its fellow distractors.

Are diagrams/graphics used where appropriate and are they clear?
The use of a diagram may be a more effective way of visualising the question / hypothesis. They need to be clear and pertinent to the question – no room for excess imagery!

EXAMPLE MCQS

The following examples and comments are taken from Bull and Danson (2002)⁴ and Carneson et al (1996)⁵.

Example 1: Carneson et al (1996)

Philosophy of Education (First year B.Ed. course)

If we understand learning a school subject on the model of learning a language we can explain

- a) why teachers do not articulate clearly.
- b) why it is not possible to explain the point of the subject to someone who does not understand the subject.
- c) why truth is important.
- d) why subjective experiences are important.
- e) why school subjects are so important.
- f) why school subjects are taught verbally.

Lecturer's approach: The lecturer's intention was that in arriving at the correct answer (b), the students must have compared each of the statements with their essential understanding of the part of the course dealing with a model of "learning a language"; and they need to be able to understand and relate:

- the concept of a "model of learning a language";
- the general concept of understanding being a process, which in the course was linked to a particular philosophical stance;
- the argument presented in option (b) "why it is not possible to explain the point of the subject to someone who does not understand the subject".

Query:

Can you identify any issues with this question? (Don't read ahead just yet!)

The correct option (b) is much longer than the distractors.

The use of the double negative (not...not") in option (b) is confusing.

One should not repeat the word "why" in front of each response, but include it as part of the stem.

BLOOM'S REVISED TAXONOMY OF COGNITIVE PROCESSES

⁴ Bull, J and Danson, M. (2002) *An Introduction to Computer Assisted Assessment and Objective Tests*. Computer Assisted Assessment Centre.

⁵ Carneson J, Delpierre G and Masters, K (1996). *Designing and Managing MCQs*. Centre for Educational Technology (CET), University of Capetown,

Competence	Indicative Skills Demonstrable
Creation / Synthesis: the ability to put facts together into a coherent whole, or, creatively achieve a new understanding by linking facts together	Question words: integrate, modify, invent, design, modify, compose, construct, create, reorganise, formulate etc.
Evaluation: the ability to make judgements using criteria and standards	Question words: appraise, judge, evaluate, defend, rank, conclude, discriminate, assess, contrast, recommend etc
Analysis: ability to determine internal relationships	Question words: analyse, arrange, order, explain, connect, infer, compare, categorise etc
Application: the ability to apply what is learned to a new situation	Question words: apply, compute, demonstrate, show, relate, prepare, use etc
Comprehension: the ability to interpret information in one's own words	Question words: interpret, discuss, predict, summarise, classify, extend, describe, etc
Knowledge: the ability to recall facts, opinions and concepts	Question words: list, define, label, describe, name, cite, match, reproduce etc

Based on Anderson et al (2001)⁶

EXAMPLE OF MCQS IN THE COGNITIVE DOMAIN

Level 1 Knowledge Carneson et al (1996)⁷

Which one of the following persons is the author of "Das Kapital"?

1. Mannheim
2. Marx
3. Weber
4. Engels
5. Michels

Note that the responses are internally consistent - they are all the names of Germans whose written work have been major contributions on social issues.

⁶ Anderson et al (2001) A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Longman, London

⁷ Carneson J, Delpierre G and Masters, K (1996). Designing and Managing MCQs. Centre for Educational Technology (CET), University of Capetown

Level 2 Comprehension Carneson et al (1996)

At this level, knowledge of facts, theories, procedures etc. is assumed, and one tests for understanding of this knowledge.

Which one of the following describes what takes place in the so-called *preparation* stage of the creative process, as applied to the solution of a particular problem?

1. The problem is identified and defined.
2. All available information about the problem is collected.
3. An attempt is made to see if the proposed solution to the problem is acceptable.
4. The person goes through some experience leading to a general idea of how the problem can be solved.
5. The person sets the problem aside, and gets involved with some other unrelated activity.

In this question, the knowledge of the five stages of the creative process must be recalled (*knowledge*), and one is tested for an understanding (*comprehension*) of the meaning of each term, in this case, "preparation". Note that this question violates the rule that the answer and distractors should all be of about the same length. It is difficult to get around this one here, so the text is edited so that each line is about the same length.

Level 3 Application Carneson et al (1996)

In order to classify a question into this group, ask yourself if prior knowledge of the background to the question is assumed to be both known and understood, and whether one is merely expected to apply this knowledge and understanding. Calculations based on known formulae are good examples of this, as shown in the example below:

Which one of the following values approximates best to the volume of a sphere with radius 5m?

- a. 2000m^3
- b. 1000m^3
- c. 500m^3
- d. 250m^3
- e. 125m^3

In order to answer this question, the formula $\frac{4}{3}\pi r^3$ must be known (*recall of knowledge*) and the meaning of the various symbols in the formula understood (*comprehension*) in order to answer this question. The correct answer is #c.

Level 4 Analysis Carneson et al (1996)

Look at the following table and indicate which countries' statistics are being reported in rows A, B and C.

	GNP per capita 1991 (\$ USA)	Growth rate of GNP per capita p.a. 1980-91	Population growth rate 1980-91	Structures of total employment 1980-85 (percentages)		
				Agriculture	Industry	Services
A	500	2,5%	1,5%	51	20	29
B	1570	5,8%	1,6%	74	8	8
S.A.	2560	0,7%	2,5%	17	36	36
C	25110	1,7%	0,3%	6	32	32

Choose your answer from the following list of possible answers:

1. A is South Korea; B is Kenya; C is Canada.
2. A is Sri Lanka; B is Germany; C is Thailand.
3. A is Sri Lanka; B is Thailand; C is Sweden.
4. A is Namibia; B is Portugal; C is Botswana.

In order to answer this question, students must be able to recall the relative economic rankings of various countries (*knowledge*) and understand the basis for such a ranking (*comprehension*). They must be able to apply these concepts when information is supplied to them (*application*), and they must be able to *analyze* the given information in order to answer the question. The correct answer is 3.

Level 5 Evaluation Carneson et al (1996)

At this level, one is asked to pass judgement on, for example, the logical consistency of written material, the validity of experimental procedures or interpretation of data.

A student was asked the following question: "Briefly list and explain the various stages of the creative process".

As an answer, this student wrote the following:

"The creative process is believed to take place in five stages, in the following order: ORIENTATION, when the problem must be identified and defined, PREPARATION, when all the possible information about the problem is collected, INCUBATION, when there is a period where no solution seems in sight and the person is often busy with other tasks, ILLUMINATION, when the person experiences a general idea of how to arrive at a solution to the problem, and finally VERIFICATION, when the person determines whether the solution is the right one for the problem."

How would you judge this student's answer?

1. EXCELLENT (all stages correct in the right order with clear and correct explanations)
2. GOOD (all stages correct in the right order, but the explanations are not as clear as they should be).
3. MEDIOCRE (one or two stages are missing OR the stages are in the wrong order, OR the explanations are not clear OR the explanations are irrelevant)
4. UNACCEPTABLE (more than two stages are missing AND the order is incorrect AND the explanations are not clear AND/OR they are irrelevant)

In the above question, one is expected to make value judgment on the content of the given text (*knowledge* of the subject is required), the meaning of the terminology used (*comprehension* of the subject matter), and its structure (*analysis* of the answer for the right order of events). The correct answer here is #1, but suitable modification of the putative student answer could provide a small bank of questions with other correct answers.

Level 5 Synthesis Bull and Danson (2002)⁸

Aim: to organise and arrange appropriate critical terms in order to construct a geological analysis of the following photographic image.

Question:

Move the appropriate descriptive terms from the list to the 'form' and 'attitude' boxes below

Question 11 0% of questions completed in 4% of time Field simulation

 **The photograph is taken obliquely to the fold axis, therefore you cannot estimate the interlimb angle. However you can describe the form of the fold and the attitude of the fold axial plane. Move the appropriate descriptive terms from the list to the 'form' and 'attitude' boxes below..**



Labels

Gentle	Close
Isoclinal	Recumbent
Asymmetrical	Synform
Overfold	Neutral
Antiform	Dome
Chevron	Steep
Vertical	Upright

Click on 'Done' when finished.

Fold Classification based on

Form of Fold	Attitude of Axial Plane	Interlimb Angle
<input type="text"/>	<input type="text"/>	<input type="text"/>

Swap Area

<input type="text"/>	<input type="text"/>
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Move pointer to term in list - click & hold left button - drag to position in label box on diagram..

Quit Skip How

End of Workbook

⁸ Bull, J and Danson, M. (2002) *An Introduction to Computer Assisted Assessment and Objective Tests*. Computer Assisted Assessment Centre.