

Universities training students for a MOOC-Education

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Abstract

Many governments and community leaders throughout the world today are looking for cost effective methods for defining, delivering and evaluating educational programs. The eLearning tools that deliver measurable completions of training courses to global audiences that address well defined training objectives, offer many attractive features. However, those engaged in this search often try to ensure that 'educational' objectives are not confused with 'training' objectives (a working definition for each of these terms is provided in the introduction). If you are trying to design eLearning packages that deliver educational objectives and are trying to avoid falling into what you perceive to be a 'trap' of delivering 'training', then this article is for you ! Sometimes the potential of an eLearning program can be reduced by a blind desire to keep training and educational initiatives entirely separate.

Multiple Choice Questions test items (MCQs) have traditionally been regarded as a tool for the assessment of successful completion of a training program, but in many cases MCQs have also been successfully applied to address educational objectives. This paper makes the case for using MCQs in the definition, delivery and evaluation of courses that address educational objectives. Two illustrative case studies are described. One is an examination of a MOOC that is delivered from the Coursera website and the other is a training course from an industrial context which includes exercises which address both training and educational objectives. The case studies are used to show how careful choices of the assessment context in which MCQs are used can help designers of MCQs to focus upon the ability of their MCQs to deliver powerful educational experiences to learners in addition to assessing the knowledge they have already acquired.

1. Introduction

In the past twelve months I have completed several MOOCs (Massively Open Online Courses) from the Coursera website (Coursera.org). In the same period I was part of a team who designed and delivered an induction course for newly recruited apprentices at my employing company (Foster 2012a).

In this paper, two case studies drawn from these experiences are described in some detail. Illustrative examples are then taken from each case study during the application of a course design process that illustrates the problems faced by every course designer. The steps include the identification of relevant content sub-domains (Grishman et. al 1986), the definition of appropriate objectives (Mager 1975, Gronlund 2009), the identification of an appropriate delivery mechanism (Gronlund 2009, Haladyna 2004), and the design of appropriate assessments (Crooks 2001, Glickman et. al. 2009) that facilitate effective evaluation (Schultz 2010, Foster 2012b).

As the course design develops it becomes clear that Multiple Choice Question test items (MCQs) can become a medium within which the activities of course design, delivery and evaluation interact. MCQs can deliver beneficial educational experiences to students when they're used in formative assessments. They also provide a convenient means for stating and refining the objectives and representing the knowledge. Techniques such as changing the context within which an MCQ is used between formative and summative assessment contexts and providing different levels of feedback (Butler et. al. 2008) at different stages of the course allow designers to address both training and educational objectives. MCQs are not just assessment tools for assessing learner progress towards training objectives. MCQs can also be effective in assessing student progress towards educational objectives and they can also be useful in the course design process.

2. The MOOC Case Study

Many of the MOOCs I have 'attended' use MCQs. However, there is one course in particular which uses MCQs in a variety of different assessment contexts. The title is 'Think Again: How to Reason and Argue' (Coursera.org). Students are invited to download video lectures and then complete formative assessment 'knowledge checks' consisting of MCQs which are instantly marked. The marking includes detailed feedback. A summative assessment 'final exam' is required to be completed before the specified deadline, which also consists of MCQs but from which no feedback is provided. In my case, I achieved 73% in the final online assessment exam which was sufficiently high for the organisers to award me a 'Statement of Accomplishment'.

This experience helped me to understand how the MCQs had allowed me to build confidence in my ability to understand and apply some quite advanced concepts, in addition to giving me feedback about my level of knowledge acquisition. If we accept that 'increase confidence in personal ability to assimilate and apply complex theories' is an example of an educational objectives, then this provides subjective evidence that educational objectives can be addressed using MCQs.

3. The TAR Case Study

The apprentice induction course I referred to is entitled 'TAR Induction' (TAR=Technical Achievement Record) and has been designed entirely in house and is delivered by full time training and development staff using the company LAN. Apprentices attend face to face lectures and complete a series of practical exercises and formative assessment (Crooks 2001) quizzes that have been woven into the learning plan of the training session. The MCQs within these quizzes are provided in an interactive mode so they are instantly marked and include immediate feedback (Butler et al. 2008). The quizzes include both Traditional 4-option Multiple Choice (4MC) test items (Haladyna 2004) and Multiple Alternative Choice (MAC)-formatted MCQ test items (Foster 2010a). When completing a MAC formatted MCQ, candidates click FOUR buttons to enter a complete response. An example of one of the MAC-formatted MCQs from this course is provided below:

Which of the following is a description of a Control Measure?	
<i>Control Measure</i>	A forecast of Lightening
<i>NOT a Control Measure</i>	
<i>Control Measure</i>	An open Manhole cover
<i>NOT a Control Measure</i>	
<i>Control Measure</i>	A Live High Voltage Conductor
<i>NOT a Control Measure</i>	
<i>Control Measure</i>	A Safety Lock and Caution Notice
<i>NOT a Control Measure</i>	

Each incorrect response in a quiz is immediately marked red providing instant feedback. On completion of the course, apprentices must achieve a 100% score in a summative assessment 'course end test' that consists of 50 MCQs which are also presented in a mixture of 4MC and MAC format. The apprentices must repeat this assessment until they have achieved the 100% score. The only feedback from the course end test is a list of the stem questions from MCQs for which they gave an incorrect response.

One month or more after completing the induction, apprentices are required to work through another summative assessment, referred to as the 'final exam'. The final exam also uses MAC and 4MC formatted items, but the exam appears different because content that was previously presented as a 4MC is now presented as a MAC and vice versa. Again the only feedback they receive is the list of question stems for the MCQs that were answered incorrectly and again they must repeat the exam until a 100% score is achieved.

In between the 'course end test' and the 'final exam', apprentices are encouraged to apply the rules they learned during the course. During this time they have access to the TAR information support systems over the company LAN. All of the rules for operating the system have been presented in the form of a FAQ (Frequently Asked Questions) document and all of the formative assessment MCQs are also available from this website. This allows the apprentices to refresh their knowledge of how the TAR system operates as they prepare for the final exam.

The TAR induction course uses an unusually large number of Multiple Choice Questions (MCQs) for a practical training environment. The formative assessment MCQs support the learning of apprentices during classroom sessions and the summative assessment MCQs measure the level of each apprentice's knowledge acquisition in accordance with the specified training objectives. This provides a working illustration of the definitions of the terms as I use them in this article. In general, summative assessment MCQs assess progress towards training objectives while formative assessment MCQs provide experiences that address the educational objectives. Although, as we will see, some educational objectives were also addressed by the feedback from the summative assessments, and there is definitely some 'training' going on as the apprentices complete the formative assessments.

4. Course Design Illustration

In the rest of this paper I will work through the course design steps for a course which could be designed, delivered and maintained by any university. Let's answer the question that many are asking "what do we want our young people to gain from a school and university education?". We will use the MOOC and TAR case studies to illustrate each of the course design steps. The aim of our course will be: "*Prepare students to obtain maximum personal benefit from MOOCs*". Once students have successfully completed the course I would want to be able to advise them to sign up for as many MOOCs as they can comfortably manage, while

these courses are still free ;)

The complete set of products from our design would be Specifications of :

- (a) Aims, objectives, source documents and preferred instructional medium;
- (b) Learning materials;
- (c) Learning resources;
- (d) MCQs and their assessment context (formative/ summative etc.);
(Learners confirm achievement of objectives to themselves and their teachers)
- (e) Evaluation measures
(Teachers confirm successful delivery of the course to managers and sponsors)

This article will provide representative samples of these products as required, and following the principles I have outlined, I believe most universities should be able to set up and deliver such a course.

5. Define The Domain

A typical response from educationalists when they are asked to design a course is first to establish the conceptual boundaries for the domain to be covered. They argue that this will provide the foundation for subsequent presentations of concepts and workshops that allow students to develop their skills in applying the concepts. They can then start to analyze more complex problems, judge the proposals of others and synthesize their own solutions. We will see later that the approach for an industrial trainer is usually different from this, but for now we will see what happens when we follow this route.

In a corporate environment this knowledge might reasonably be assumed to be provided by the company's rules and procedures. For instance, in the company where the TAR apprentice induction course was delivered, these rules and procedures are defined in the company's library of approved documents. However, when we try to decide which details should be included in the MCQs and which can be safely ignored, we realize that these documents are subject to regular alteration and change. Between the time when the MCQ was first created and the time when the learner uses the MCQ assessment, there is a good chance that at one item of knowledge that was judged to be appropriate will have become inaccurate or rendered obsolete by events either within the company or in the world outside.

In the academic environment illustrated here by the Coursera MOOC, there are other problems. Not only are there regular additions to the academic literature that can render theories obsolete soon after they have been published, but there is also such a vast array of theories and techniques to choose from, that deciding which should be included and which can safely be ignored, becomes a significant problem.

Perhaps a different approach is required? Let's explore the recommendations from theorists in the field of industrial training

6. Define Assessment Objectives

Influential theories in the activity of defining instructional objectives for industrial training include the recommendations from Robert Mager (Mager 1975) and Norman Gronlund (Gronlund 2009). Their advice is that course designers must first decide upon their aims and objectives. Once the general aim has been defined, the next step suggested by Gronlund is to describe the final outcome from the course. How will learners behave once they have learned the lesson we're trying to teach. Once we have defined our objectives we can then apply criteria to identify appropriate content and make rational decisions about what should be included.

So, for our illustrative course design we have been given a course aim (*I have also heard this labeled a 'communicative goal'*). The course aim (goal) is to:

"Prepare students to obtain maximum personal benefit from MOOCs".

The next step of writing specific objectives must be done with care because it is easy to produce objectives which are not specific or measurable. An example of an objective that I believe illustrates this point is a typical statement of the criteria that must be met for the award of a Ph.D:

"The candidate must present a dissertation on a topic related to his or her area of specialization that presents the results of original research and gives evidence of excellent scholarship. The dissertation must be approved by the professor or committee under whose direction it is written and by the Graduate Council. All requirements for the Ph.D must be completed within five years after advancement to candidacy."

The writers of this objective are unable to include a specification of the sub-domain since the statement must be true for all Ph. D students in all disciplines. By contrast the objectives for our course are likely to specify the sub-domain to which our learning will be restricted. Another weakness in the 'objective' quoted above is the assumption that everybody knows what is meant by 'original' and 'excellent scholarship', so these terms are not defined. By contrast in the objectives we produce for our course there must be definitions of all terms within the terminology. Some criteria are specified for the performance expected of Ph. D students, but these criteria are intrinsically subjective and vague as they depend upon the judgment of an individual or a committee. At least one aspect is clear. The student must complete within 5 years !

If we contrast the previous statement with the objective that I set for myself when embarking

upon my own Ph.D, we can see some more concrete specifications (although if there are aspects which you think could be tightened up then please get in touch !):

"Before the Ph. D term has been completed, there should be improvements at my employing company to the current systems for the creation, delivery and maintenance of Multiple Choice Question (MCQ) test items that will:

- (a) Provide evidence to all interested parties that the company has met (or exceeded) their responsibilities under the Health and Safety at Work, etc Act 1974 for all relevant fields of knowledge.*
- (b) Reduce likelihood of disputes over validity by drawing content directly from a traceable source text for an identified target population covering a clearly defined field of knowledge.*
- (c) Manage Change by avoiding expensive revisions of manually created MCQ test item banks following changes in fields of knowledge (eg changes to national legislation)*
- (d) Increase efficiency of MCQ test item creation by saving the time of our item designers, validators and users (trainers and trainees)."*

Extract from Proceedings of the MCQ-Creation Workshop (London International Conference on Education 2011)

This objective was produced using the framework for objectives that is introduced by Robert Mager (1975) and developed by Norman Gronlund (2009). The suggestion is that objectives should specify the Audience, Behaviour, Context and Degree (ABCD). If we were to apply this method to our course design example then one of the objectives might have the following components:

Fragment type Objective Fragment

AUDIENCE A university student in any country on Earth

BEHAVIOUR: Recognise statements written in English that describe the benefits of a MOOC-based education.

CONDITION 1: Has the ability to read and write in English.

CONDITION 2: Has access to a sufficiently high bandwidth connection to the internet to enable them to view video lectures.

DEGREE: The statements students recognize should include:

- 1) "You choose when you learn, and so discover your own learning style"
- 2) "You hear presentations from globally recognized experts"
- 3) "You receive feedback from globally recognized experts and highly skilled teachers when you respond to the MCQ assessments and then get

your responses marked”

4) “You interact with a global population of fellow students through the Discussion forums and peer review exercises”

The objective has been restricted to the checking of student’s ability to **recognise** (level 1 in the Cognitive Domain of Bloom’s Taxonomy) the benefits of making best use of MOOCs. There is no expectation that successful completion of the MCQ test items would provide confirmation of abilities at higher levels within the cognitive domain such as understanding, application, analysis, synthesis or evaluation. Any of these levels which are relevant to the particular student must be addressed using other approaches, including counseling and selected experience.

However, this statement and the others that would need to be produced as part of a full design, clarify each aspect of the course designer’s understanding of aim they have been instructed to address. This statement also allows the designer to make accurately targeted choices about source documents and the most appropriate instructional mechanism. The course designer can also choose an appropriate format and assessment context for one or more MCQ test items that will then check for knowledge acquisition and demonstrate successful completion of the objective. Once we have defined the objectives and used them to identify the appropriate source documents, the next step is to select an appropriate instructional medium.

7. Define the preferred instructional medium

Most systems for defining objectives build upon the foundation of Benjamin Bloom's taxonomy of learning (Bloom 1956), although Gronlund’s book includes subsequent modifications to the taxonomy. Bloom’s taxonomy includes hierarchies in three domains: affective, cognitive, and psychomotor. Practical experiments that have examined Bloom's cognitive domain model have been largely supportive of the theory. In particular, the principal that learners should meet learning objectives at lower levels before they are ready to tackle objectives at higher levels is a widely accepted maxim. If a learner has met sufficient objectives at level-1 (knowledge) then they possess a foundation of cognitive learning that means they can start to tackle learning objectives at level-2 (understanding).

This is important when we consider the possibilities for MCQs in eLearning because if we accept that:

(a) level-1 knowledge is the required foundation for progress to all higher levels of the cognitive domain of Bloom's taxonomy

and

(b) the objectives of an educational program can be specified in ways that allow the level-1

knowledge to be identified

and

(c) MCQs can be designed to assess acquisition of the identified level-1 knowledge

... then when a learner has selected a sufficient number of correct responses to the MCQs that define the foundation level-1 knowledge, they have produced measurable evidence of progress towards the program's objectives !

This measureable quantity reflecting achievement is not affected by the refinements and qualifications at higher levels within the cognitive domain of Bloom's Taxonomy (such as the proposal for equivalence of Creativity and Evaluation etc.), because whether the learning is at level 5 or level 6 it is still all enabled by the acquisition of a foundation of knowledge at level 1. However, perhaps there are yet more benefits available from using MCQs?

In contrast to the cognitive domain, practical support for Bloom's psychomotor and affective domain theories is less well developed. More variations are offered from alternative theories. However, perhaps my experiences described briefly in the case studies, provide some evidence that supports the idea that MCQs can address educational objectives in the Affective and Psychomotor domains (or their equivalent manifestations within other theories about learning) as well as in Bloom's Cognitive domain?

When a learner achieves a 'pass' in a MCQ test, there can be a feeling of self-affirmation. The learner has received CONFIRMATION that they have now acquired a foundation (level-1 knowledge) that is required for them to progress to educational objectives at level-2 (understanding). Thus a degree of confidence (Affective) has been assessed and confirmed to be present. There are also some developments in the psychomotor domain (or its equivalent) that learners must achieve if they are to progress through an online eLearning course. Therefore my assertion is that the MCQs themselves might become the instructional medium !

Creating Assessment MCQs

Once we have statements of the aims and objectives for our course, and we have decided to deliver the material using MCQs then this can provide further guidance to the course designer, allowing them to make follow up decisions about suitable content and the boundaries to conceptual sub-domains. This provides all the material required to create the MCQs that will be used to assess the achievements of students and to give them feedback as to whether or not they have successfully completed the course.

The next set of decisions surround whether the MCQs will be presented in formative or summative assessment contexts. Let's look again at the MCQs that were used in the two cases studies:

In the MOOC Case Study, MCQs

- (a) Formative MCQs prompt learners to repeat lectures and other formative exercises
- (b) Formative MCQs encourage additional internet research and supporting reading
- (c) Summative MCQs confirm adequate knowledge on completion of the course
- (d) Formative and Summative MCQs give increased confidence to learners in their ability when they achieve a pass
- (e) Formative and Summative MCQs encourage learners to develop increased mental agility as they adjust to new structures of the learning material and new 'features' of the learning environment

Meanwhile in the TAR Case Study 2, MCQs:

- (a) Formative MCQs prompt apprentices to remember details from the lectures.
- (b) The prospect of the Summative MCQs in the end test prompt apprentices to reinforce their learning by referring to course notes, asking questions and locating online resources.
- (c) The prospect of the Summative MCQs in the final exam prompts apprentices to apply the procedures they have learned and regularly remind themselves of the details using the online resources.
- (d) A 100% score in the Summative MCQs in the final exam proves to trainers and learners that the minimum level of knowledge has been acquired that will enable the apprentice to progress to higher levels of learning in the cognitive domain.

Therefore, the list of products from our course design exercise can now be simplified down to the following items which can all be created using the guidelines that have already described:

- (a) Specifications of aims, objectives, source documents and MCQ as the preferred instructional medium;
- (b) MCQs and their assessment context (formative/ summative etc.);
(Learners confirm achievement of objectives to themselves and their teachers)
- (c) Evaluation measures
(Teachers confirm successful delivery of the course to managers and sponsors)

When the course is first delivered it is likely that video lectures or even face to face lectures will be required to deliver most of the formative exercises. However perhaps we can imagine a future, which has already been partially realized in the TAR case study, of an increasing percentage of the course content being delivered through MCQs presented in a formative assessment context. If we add the idea of embedding formative assessment MCQs within game and other interactive video exercises, then perhaps this helps us to see how this might become a reality.

8. Discussion

Education Professionals might be concerned at the loss of many of the usual trappings of an educational experience that I have proposed in this course design. First we have specified objectives that constrain the freedom of students to discover for themselves and then I have further restricted the possibilities for discovery learning by constraining the instructional mechanism to MCQs which only allow students to make choices to closed questions instead of answering open questions and then receiving feedback.

My response is that my own experience that was reported in the MOOC case study and the experiences reported by apprentices on the apprentice induction course described in the TAR case study, suggest that MCQs can prompt learners to undertake the other learning activities on their own. If the MCQs have been correctly designed in the context of well defined performance objectives then they help learners to understand more quickly what is expected from them. then they arrive at the classroom, asking questions and eager to learn.

Perhaps this kind of course design could make the job of the face to face teacher/lecturer more enjoyable? Poor pupils and students will have already received focused feedback about their lack of knowledge through low scores on the MCQs out of class time and then done the necessary remedial work. High achieving students will have proved to you and to themselves that they already know the material. So when they arrive at your class they either immediately start asking questions or are happy to answer questions. Perhaps the class will teach itself ! These benefits are in addition to those already identified, whereby the physical activity of answering MCQs and then receiving feedback can of itself help learners to make progress towards the educational objectives which we know are there but which are more difficult to specify and more difficult to write into MCQs.

Training professionals will be familiar with the concept presented in the section entitled 'Defining Assessment Objectives' where the process for defining 'Performance objectives' was described. This idea is not emphasized in education because the idea of objectives appears to restrict the learner. We're often encouraged to think of education as a process of 'drawing out' behavior patterns from pupils as opposed to pushing prescribed behavior onto them, but perhaps you now realize that my point in this paper is to encourage you to consider ignoring this principle on some occasions.

My own instinctive inclination is to agree with educationalists that restricting the thinking of our students is not what we are paid to do. However, in this instance, I believe it is appropriate, and indeed necessary, that students are provided with a certain amount of training to help them to make best use of the resources that have been made available by

some of the most energetic minds of our generation, while they are still freely available.

9. Conclusions

The rather radical suggestion from this paper is that Multiple Choice Questions (MCQs) can actually deliver the majority of the formative and summative assessment activities that cover the supporting knowledge requirements on a training course that is focused upon practical skills training. The TAR case study shows us that this is already happening.

The suggestion from our discussion is that perhaps the main requirement that students will make from the people who work in our universities is for practical and emotional support and advice as they make use of online formative and summative assessments to address their need for education. One focus for such activity might be training students in the knowledge, skills and attitudes they need if they are going to take maximum benefit from education that is now available to them from MOOCs. Universities who choose to adopt a training approach when dealing with their students in this matter will perhaps prepare students more effectively than those who persist with the live, face to face model in their efforts to create educational opportunities for their students.

10. Recommendations

We recommend that the course design specified in this paper is applied in as many universities as possible so that Students can take maximum benefit from MOOCs while they are still freely available. We also suggest that strategy at universities might change to become more closely aligned to training practices in Industry. The focus could become the preparation of students for the task of learning using online resources. Another way of saying this is that we suggest universities 'training their students to learn' as opposed to continuing the educational emphasis that is still prevalent in schools.

Universities might soon need to consider a similarly 'reversed' model to the one being applied in an increasing number of schools. The model involves students viewing video lectures and completing formative exercises in their own time, as 'homework', and then coming to class in order to do what was previously regarded to be 'homework', as they make use of what they have learned in exercises.

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Appendix A

MCQ-Creation Methodologies Workshop

(20 November 2012, London, United Kingdom)

... in conjunction with LONDON INTERNATIONAL CONFERENCE on EDUCATION 2012

"At MCQ-Creation we discuss empirical studies of MCQ creation methodologies and then suggest improvements."

Background

The specific objectives of assessment authorities and the languages of learner populations are continually changing. This implies that assessment tools, which are used to confirm accurate transfer of knowledge to learners within a domain of discourse, must also change. The MCQ-Creation Workshop brings together educationalists from industry, governmental examining bodies, universities and schools to examine the merits and pitfalls in traditional processes for creating Multiple Choice Question (MCQ) test items. The output from the workshop will be proposals for new (or adapted) MCQ creation methodologies that are appropriate to the domains defined by the presenters.

Programme

Welcome and introductions, followed by a summary of the aims of MCQ-Creation

Introduce My Domain (Summary of recent research)

Unit 1 - Lecture 1: Defining domains

EXERCISE 1: Describe YOUR domain

Unit 1 - Lecture 2: What should be tested / measured?

EXERCISE 2: What will you test / measure in YOUR domain?

Unit 1 - Lecture 3: Validity

Unit 1 - Lecture 4: How do we measure achievement?

EXERCISE 3: What are the available types of MCQ?

Unit 2 - Lecture 1: The MCQ Creation Process

EXERCISE 4: Important components of the MCQ-Creation process

Unit 2 - Lecture 2: The MCQ Creation Guidelines

EXERCISE 5: Important Guidelines for your domain

Case Studies:

- **High Voltage Cable Jointing**
- **Heavy Plant Lifting**
- **Apprentice Progress Monitoring**

EXERCISE 6: What have you learned?