The use of multiple-choice questions (MCQs) examination as a way to minimize the cost of education – shines and shadows.

Pedagogiskt docenturarbete

Emilia Wiechec
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**Background**

The higher education sector has become increasingly competitive marketplace, where good quality learning is a key issue in the future success of a student. The demand for high quality education, while at the same time being of high economic efficiency, forces the educational institution to change its approach to the teaching process.

The main purpose of the teaching process is to provide students with solid knowledge in a given subject area and knowledge-based foundations for future career. However, an integral part of learning process is examination. The word exam originates from the Latin word *examen* and means *testing* or *checking*. The main object of examination is knowledge, which reflects achievements of the learning objectives. Exams take usually form of a final verification, which constitutes completion of the course. The effect of such exam should be the belief that students possess desired knowledge of the given subject. Examination can also be considered as assessment in order to help explaining, determining, monitoring and promoting student’s learning. The meaning of assessment can depart from its original goal and can be understood as judgement about something. This phenomenon is known in the education field as the *paradox of assessment*. According to Professor Douglas Orzolek "assessment should be about what students have learned and not what has been taught to them".

Forms of examination in medical sciences have undergone transformation over the past years. Initially, oral exams were accepted as the only acceptable form of examining students followed by written examination consisting of open questions. A relatively new form of examination, which has become to an increasing extent prevalent in modern education, is *multiple-choice questions (MCQs)* examination, which can demonstrate students' knowledge and skills (1). Such testing method certainly saves time, covers larger areas of learning and most likely reduces the cost of this process. The best practices in an effort to provide guidelines for teachers in writing effective multiple-choice questions have been widely studied and all gathered information can be extremely useful in educational practice (2-5). Furthermore, the
modern information technology is easily accessible in any place thanks to the fast development of internet.

We successfully implement this type of examination within the "Stem cells and applied regenerative medicine" course offered by the Experimental and Medical Biosciences master’s programme at Linköping University. This form of examination is considered to be objective (giving equal opportunities to all students; for identical answer, all students receive the same number of points), fair and quick. Although MCQ-based examination does not allow for student’s own interpretation and development of the issue to which they relate, on the other hand, they allow checking a wide range of knowledge and completely unbiased assessment of answers. Therefore, it seems that there is no ideal form of examination and MCQs have also shortcomings. Opinions are divided among students and examiners. Students usually prefer those forms of examinations in which they perform better. Regardless of the form of exam, teachers care about the most accurate picture of the knowledge acquired by the student.

In my pedagogical reflection I will present a short, literature-based list of recommendations for reliable and relevant MCQs in order to measure student’s learning. I will also discuss advantages and disadvantages of this form of examination as well as their ability to provide a good measure of acquired knowledge. Furthermore, the adjustment of MCQs to problem-based learning (PBL)-supported education will be also mentioned.

**Multiple-choice questions – principles of construction**

The current educational process in terms of examination is dominated by a model in which teachers ask questions and students based on the given answers receive marks (passed/not passed). From the student’s perspective, asking the right question often seems to be as cognitively valuable as answering the question. Exams comprise culmination of the teaching process and are intended to examine basic skills that all students must master. MCQ-based examination form is not that uncommon in biological sciences and if well designed can measure student’s understanding, ability to concentrate and applying knowledge in different situations.
This is because they can measure really complex things, for example, to track how the student came to a given answer. It is not about mindless crossing A, B or C. In cognitive psychology, memory processes are based on three basic phases, namely coding, storage and extraction. Extraction is related to the way in which information stored in memory is accessed and involves two separate processes such as recall and recognition. Recognition involves identifying information from the sense organs as already known. This process is utilized during MCQ-based examination when students associate one of the proposed answers with their knowledge.

Briefly, the MCQ consists of a stem (in a form of question, statement or order), correct answer and a set of incorrect answers (distractors). It implies that the correct answer to a given question depends on the proper understanding of the core of the question (stem). It is therefore extremely important to pay attention to the construction of such questions.

A recent article by Andrew C. Butler (Associate professor of education and of psychology and brain sciences at Washington University St. Louis, USA) presents in an elegant way a summary of practices regarding assessment by MCQs (4). The brief overview of five best practices that should be taken into consideration while constructing MCQs are shown in Figure 1. The overall idea of a good and reliable MCQ is that it should be simple in format. There are several configurations of MCQs, which differ among themselves in regard to question components. One example that should be avoided is so called complex MCQ, which consists of stem, list of potentially correct answers (primary response) and list of combinations of primary responses (for example: A and B; C only; all/none of the above). Despite the fact that this kind of question seems credible and challenging, it does not fall well in research on advantage of complex MCQs over simple MCQs (6). Simple MCQ does not mean easy and not stimulating. Preparation of an accurate and reliable MCQ that will measure learning outcomes requires a teacher thoughtful action. The correctness of the answer is closely related to proper understanding the content of the question. Moreover, the selection of language resources and the correct structure of the question (in terms of logic) is very important. In general, the use of unclear language terminology, implausible answer options, heterogenous content of answer options (grammar, length, formatting) are the most common mistakes when designing MCQs.
Furthermore, the "all of the above" as well as "none of the above" as alternative answer is generally not recommended (or used carefully) in the construction of MCQs due to increase of question complexity and difficulty (7, 8). We have experienced also in our course that many students do not like such complex questions arguing that "these questions introduce confusion and question their knowledge". It is quite natural that concise and accurate instructions are easier understood than those complexed ones. Teachers must be aware that the level of language accuracy when designing exam questions should correspond to the level of student's education and not to the level of teacher's education. However, in many cases (taken form our MCQ-based examination at LiU) choosing the correct answer was usually associated with the formulation of stem such as negatively worded stem, which could influence student's answer. In order to avoid student's oversight in regard to negatives in stem, we always highlight the negative term with capital letters. What's more, simplified vocabulary in the MCQs has a significant impact on student's performance. I would like to mention that for nearly 80% of master students who sign for courses within the Experimental and Medical Biosciences master's programme are not native English speakers. Therefore, exaggerated overuse of difficult vocabulary places students at risk to fail.

Figure 1. Literature-based distinct characteristics of a well-constructed MCQ.
Meta-analysis studies have also shown that giving students three reasonable response options (including the correct one) is sufficient to achieve the intended goal in a given question (2, 9). In addition, the ideal MCQs require students to engage specific cognitive processes in order to answer the question (10). Cognitive style is related to mental behaviors, which individuals apply habitually when they are thinking and solving problems. Bloom's taxonomy gives teachers opportunity to look at complex cognitive abilities as a way to engage students in higher-order thinking. There are six well described levels of cognitive behavior (Figure 2) that can be subjected to examination with MCQs. Choosing the right verbs and question stems seems to be critical for the MCQ-based exam to succeed. Testing skills that in fact produce learning such as analysis, evaluation and synthesis are believed to be superior to learning of facts and memorizing (11).

![Figure 2. The hierarchy of Bloom's taxonomy and representative stem components for the design of MCQs.](image)

We should keep in mind that the Medical Faculty of Linköping University follows the educational principles of Problem-based learning (PBL). Testing analytical skills, integration, application of knowledge and problem-solving skills is a big challenge for the MCQ examination in PBL-based curriculum. Samy A. Azer (from the School of Medicine, University of Melbourne, Australia) has suggested several tips for designing MCQs that test cognitive skills (12). It is advisable to use a case scenario in the question stem in order to address specific educational objectives. We have
experienced that picture-based MCQs constitute also a good way to examine knowledge. Furthermore, using sequence questions, where answer from preceding question constitutes stem for the next question allows testing student's ability to combine facts and apply knowledge. We successfully implement this form of MCQs within the "Stem cells and applied regenerative medicine" course.

Last but not least, the ease of the exam should be adjusted so that it measures the skills of the entire population of the students. Too difficult or too easy MCQs will be of little use to discriminate between students who acquired and have not acquired the desired knowledge.

Taken together, designing of a reliable MCQ-based exam that will test the actual skills and knowledge of the students requires a lot of teacher's effort and is time consuming. This might be considered as disadvantage in regard to minimizing the cost of education at the level of examination. The inability of students to create syntheses and independently present his/her own analyzes, views and conclusions can also cast a shadow over this type of examination. This issue might be important at the early stage of university education and only MCQ-based examinations can interfere with this process. Additionally, the "lucky factor" (the possibility to guess) in marking the right answer can disrupt the actual state of student's knowledge. The common practice in this case is awarding negative points for an incorrect answer. I know from my own experience that this method is not appreciated by the students and introduces additional stress as well as fear of answering the question. Students treat this form of scoring as "punishment" for lack of knowledge, but in fact this method helps to assess how confident the student is in answering the question. Regarding the subject mentioned above, introducing negative points is a good way to avoid dishonesty and information about this procedure should be clearly stated in the course syllabus.

Fortunately, there are also positive sides of MCQs-based exams. If well-constructed, they can stimulate student's thinking process placing him in a decision-making situation. They are definitely easier to check, provide objective scoring (limiting scoring bias) and span wide range of learning objectives (any scope of educational content) when compared with open questions.
Final reflection

The MCQs-based examination, which is the subject of my pedagogical reflection, is a commonly accepted form of controlling the knowledge acquired during the teaching process. I would like to highlight the challenges that teachers face in order to design well sound MCQs. Exam should be always adapted to the assumed learning outcomes in a given subject area regardless of its form. Taking into account a number of other duties of an academic teacher (including continuing pedagogical development and research), it is not surprising that MCQ-based exams are preferred. The relatively lower amount of time needed to receive and evaluate the results of MCQ-based examination, gives rise to the temptation to use this tool in such a way and for purposes for which it is not intended.

In any case, the student should always be in the center of interest and the teachers contribute greatly to the production of valuable graduates that appear on the labor market. Each teacher, taking into account the significance of the taught subject, should himself/herself determine what knowledge is expected from the student and choose the form of the exam adequate to these expectations.

REFERENCES:


