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An introduction to Scientific, Educational, Linguistic & Formative (SELF) evaluation strategies for a subject- specific multiple choice questions exams

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Abstract : Multiple choice questions (MCQ) exam is the gold standard for testing knowledge acquisition and comprehension within academic as well as professional fields. Many novice and inexperienced academics are lacking the needed skills to develop high quality MCQs exam which allows less capable learners and test takers to take the advantage of passing the exam without having the genuine competence. The author has introduced the SELF evaluation strategy to guide academics to design robust MCQs exams. The author has exclusively included a number of real MCQs with its best answer. Questions were supported by its difficulty and discrimination indices. The SELF evaluation strategy is a simple, logic, and comprehensive process that should be vastly adopted by academics to develop high quality MCQs exams.

Keywords: Scientific, Educational, Linguistic & Formative (SELF) evaluation strategies, multiple choice questions.

Introduction

Scientific, educational, linguistic & formative (SELF) evaluation process was originally created by Dr. El-gohary who has over 25 years of experience at multiple academic and clinical settings.^[1] SELF is acronym used as mnemonic to guide academics to develop high quality multiple choice questions (MCQs) exams. SELF is purported to guide academics to evaluate of the scientific, educational, linguistic and formative aspects of MCQs of different tests within different fields. SELF evaluation is increasingly used by academics that have been trained to use it. SELF evaluation of MCQs exams is more likely to have a significant impact on creating and developing MCQs exams at college of medical rehabilitation sciences, Taibah University. There is a plan to spread the SELF evaluation process in Kingdom of Saudi Arabia and internationally. The scarcity of guiding principles to create and develop MCQs within the field of physical therapy and rehabilitation has prompted Dr. El-gohary to share his expertise to guide MCQs developers.^[1] For the purpose of discussion within this paper, a sample of MCQs that were included in the midterm and final pathomechanics exams will be evaluated using the SELF evaluation process. The rationale behind choosing specific answer while excluding the rest will be fully discussed in order to educate academics about the best approach to substantiate the chosen answer. The correct answer that is supported by evidence will satisfy the scientific aspect of the SELF evaluation process of the given MCQ. Right after, the academic should satisfy the educational, linguistic and formative aspects of the questions.^[1,2] Using the SELF evaluation for the pathomechanics course will be considered as subject-specific

SELF evaluation; however the general outlines of using SELF evaluation is considered as generic SELF evaluation.^[1-3] The acquired academic skills from creating and developing the MCQs for the pathomechanics course should be dragged on enhancing the necessary skills needed to create and develop MCQs for different courses.^[1-3] Despite discussing medical examples and focusing on pathomechanics as a subject specific example, the acquired skills will be fundamental to all academics to develop high quality exams that reflect distinguished educational program. It is hypothesized that the recently created SELF evaluation process would serve as simple, systematic assessment strategy that will be vastly adopted by academics to prepare high quality MCQs exams.

Materials and Methods

Sampling

A miscellaneous sample of MCQs from different exams of the pathomechanics course was carefully chosen to represent different educational categories, scientific level of evidence, linguistic correctness, and formative output. The author in the following section will discuss real sample of MCQs with its four answer options. The author will guide the readers through the SELF evaluation process of including and excluding the answer options to decide which should be the best available answer.

Q₁: Adam is 37 years old male with chronic gout and significant pain at metatarsophalangeal joints “MTJ” of the big toes that slowing down his walking speed. Which subphase of the gait cycle that is more likely to be affected?

- a) Initial contact to loading response
- b) Loading response to midstance
- c) Midstance to terminal stance
- d) Terminal stance to preswing

Comments:

The correct answer is (d) since the subphase of terminal stance to preswing has the tibia in the maximum forward tibial position while the foot fulcrums on the ball of the foot. The foot position puts the maximum pressure on the metatarsophalangeal joint of the big foot which is always the common site of flare up of gouty arthritis.^[3] The “a”, “b”, and “c” options have less or much less pressure on the metatarsophalangeal joint of the big foot. The academic chose to include all subphases belongs to the stance phase of the gait cycle without having any subphase of the swing phase. Regarding the SELF evaluation process, the scientific soundness of the short case scenario was established and was supported by many original research works within the field of pathomechanics.^[3] The educational aspect of the question was satisfied since it covers the analysis-evaluation spectrum of Bloom’s taxonomy.^[4-8] The question and its answer options reflect higher critical thinking skills that necessitate clinical reasoning and clinical judgment which are fundamental to develop learners’ capabilities.^[9-13] The academic must have the course objectives and intended learning outcomes handy to align it with the proper teaching strategy and the evaluation technique.^[14-16] The course objectives should be within the umbrella of the program objectives driven from the vision and mission of the program. In reference to the course objectives 1) to recognize and screen for common foot and ankle pathology; and 2) to perform observational movement analysis of foot and ankle to identify common impairment faults leading to foot/ ankle dysfunction; both were tested using the above mentioned case scenario. Also, the case scenario addresses the program objective of developing physical therapists abilities to practice the profession without limitations in accordance with national and international standards of physical therapy practice.^[17-20] The linguistic aspect was also satisfied since the choice of the best answer was not driven by grammar matching. The formative aspect of the question was also satisfied since all answer options have the same length and follow the logical sequence of the sub-phases of the gait cycle.^[1-3] Moreover, the question seems to test higher level of cognitive skills which needs good visualisation skills from the test taker.^[1,2,5-8] Guessing will be hard since the subphases of the gait cycle are overlapping and all could be plausible answer to the question but the test taker needs to choose the best answer based on the best available evidence.^[1,2] Furthermore, the question is not only test the theoretical background of the test taker but the clinical-practical reasoning skills. Clinical reasoning is fundamental to have sound clinical judgment skills.^[10-13] The case based scenario communicates a very common pathologic case that physical therapist and health care providers are encountering every day.^[3,21] It has no cure and will require life-

long treatment and rehabilitation. Physical therapists and rehabilitation providers need to address the suffer of the patients and help him/her to achieve maximum functional independence. Functional mobility and independent locomotion come at the top of the hierarchy of functional independence. It is the main responsibility of physical therapists to restore locomotion and improve gait pattern.

Q₂: Youssef has acute left ilio-psoas muscle strain. Observational gait analysis will demonstrate:

- a) Normal gait pattern
- b) Narrow step width
- c) Short right step length
- d) Short left step length

Comments:

The correct answer is (c) since the acute left ilio-psoas strain will suffer the most when subjects to tensile stretching force. Visualisation of pathologic gait pattern, using simple observational gait analysis, demonstrated that the right leg swing phase was associated with the terminal stance- preswing sub-phases of the left leg. Patient with acute left iliopsoas muscle strain tends to shorten the right leg step length to minimize the tensile stretch force of the affected left iliopsoas muscle.^[3]The “a”, option is excluded because patient with acute muscle strain cannot walk with normal gait pattern, “b” option is excluded because step width is in the frontal plane which is more likely to affect abductors/ adductors muscle group, and “d” option is excluded since the left step length is less affected because the tensile stretch force will be mainly on the unaffected right iliopsoas muscle. Regarding the SELF evaluation process, the scientific correctness of the stand-alone MCQ was established and was supported by many original research works within the field of pathomechanics.^[3,21] The educational aspect of the question was satisfied since it covers the analysis- evaluation spectrum of Bloom’s taxonomy.^[4-8] The question and its answer options reflect higher critical thinking skills that require clinical reasoning and clinical judgment which are fundamental to develop learners’ capabilities.^[10-13,22-25] Linguistic and formative aspects were satisfied.^[1,2]Moreover, the question reflects course and program objectives. The question communicates a very common post traumatic case that rehabilitation specialists and physical therapists are encountering every day in their practice.

Q₃: Patient with complete tear of anterior cruciate ligament “ACL” tends to have:

- a) Increased glide and roll osteokinematics
- b) Increased glide and roll arthrokinematics
- c) Decreased rock and roll arthrokinematics
- d) Decreased rock and roll osteokinematics

Comments:

The correct answer is (b) since the ACL is responsible for the arthrokinematics and internal joint stability. Arthrokinematics includes liding, rolling and spinning joint surface motion which tends to excessively increase after sustaining complete ACL injury.^[3] The option “a” is excluded since osteokinematics includes segmental motion which is controlled by skeletal muscles. The osteokinematics is less likely to be affected after ACL complete tear and when it is affected it is less than the arthrokinematics of the knee joint. Options “c’ and “d” are excluded since the complete tear of the ACL leads to knee joint instability not knee joint stiffness. The joint instability is always concomitant with excessive, uncontrolled arthrokinematics and osteokinematics. Regarding the SELF evaluation process, the scientific correctness of the stand-alone MCQ was established and was supported by original research works within the field of sports pathomechanics.^[3,21] The educational aspect of the question was satisfied since it covers the knowledge- comprehension spectrum of Bloom’s taxonomy.^[4-8] The question and its answer options reflect lower order thinking skills that require recalling and interpretation of the given information which are fundamental to develop learners’ competence.^[1,2,24,25]The question has covered not only the factual knowledge but has covered the conceptual and procedural knowledge as well. Linguistic and formative aspects were satisfied. Moreover, the question reflects course and program objectives. The question communicates a very common post traumatic case within sports field that physical therapists and rehabilitation specialists are encountering every day in their practice.

Q 4: Omar is 63 years old retired school teacher who suffered from stroke two years ago. Omar has moderate to severe spasticity in the right upper limb. Kinematic analysis of the mentioned stroke patient is more likely to demonstrate:

- a) Flexion, adduction and internal rotation with poor arm swing
- b) Flexion, adduction and internal rotation with good arm swing
- c) Extension, adduction and internal rotation with poor arm swing
- d) Extension, adduction and internal rotation with good arm swing

Comments:

The correct answer is (a) since stroke patients tend to have the upper extremity in flexion, adduction and internal rotation. Postural analysis will allow the physical therapist to specify the static position of the upper extremity. Observational gait analysis will allow the therapist to evaluate the quality of arm swing. It is expected to see poor arm swing when there is moderate to severe spasticity.³The physical therapist needs to have good comprehension of the neurologic disorders. Also the academic, in the above stated question, has tested a higher order thinking skills since the learners tend to synthesize the analysis and evaluation category to come up with the best answer based on the best available evidence.^[1,2]Regarding the SELF evaluation process, the scientific soundness of the short case scenario MCQ was established and was supported by original research works within the field of neurologic pathomechanics.^{3,21} The educational aspect of the question was satisfied since it covers the analysis- synthesis spectrum of Bloom's taxonomy.^[4-8] The question and its answer options reflect higher order thinking skills that require analysis and evaluation to synthesize the findings of the given neurologic patient. The included physical assessment findings are fundamental to develop learners' competence within the neurologic section of the pathomechanics course.^[22-25] The question has covered procedural knowledge as well as metacognition.^[1,2] Linguistic and formative aspects were satisfied. Moreover, the question reflects course and program objectives. The question communicates a very common post stroke case within the neurologic field that physical therapists and rehabilitation professionals are encountering every day in their practice.

Q 5: Sara is 26 years old college graduate who had sustained traumatic left hip injury that resulted in left gluteus medius(GM) weakness. Compute the muscular force of GM needed to balance 90Kg total body weight that has 20cm moment arm. The GM has 5cm moment arm and the patient managed to balance on the single left leg standing?

- a. About 70 Kg.cm
- b. About 300 Kg.cm
- c. About 25 Kg.cm
- d. About 110 Kg.cm

Comments:

The correct answer is (b) since the learner needs to multiply the 90 Kg by 5/6 to obtain the experienced body weight over the left hip. Given that the patient managed to balance on the left leg then clock wise and counter clock wise moments must have been on a state of balance. The counter clock wise moment will be the product of the body weight of 75 Kg multiplied by 20cm of the body weight moment arm while the clock wise moment will be the product of the GM muscle force multiplied by 5 cm GM moment arm.^[3]Regarding the SELF evaluation process, the scientific soundness of the short case scenario MCQ was established and was supported by original research works within the field of pathomechanics.^[3,21] The educational aspect of the question was satisfied since it covers the application- analysis spectrum of Bloom's taxonomy.^[4-8] The question and its answer options reflect higher order thinking skills that require computation and analysis of the given patient. The included computational question is fundamental to develop learners' competence within the applied section of the pathomechanics course.^[22-25] The question has covered procedural knowledge as well as metacognition.^[1] Linguistic and formative aspects were satisfied. Moreover, the question reflects course and program computational objectives. The question communicates very common torque calculation skills necessary for physical therapists and rehabilitation professionals to master in studying pathomechanical course.

Q₆: 8- year old child with excessive anteversion is more likely to *walk with*:

- a) Toe in gait
- b) Tip toes gait
- c) Trendelenberg gait
- d) Toe out gait

Comments:

The correct answer is (a) since the femoral anteversion is one of the most common hip deformities that result in compensatory toe in gait.^[3]The option “b” was excluded because it can be seen when there is significant tightness or hypertonicity of the ankle plantar flexors. Option “c” was excluded because it always happens when there is weakness of hip abductors. Option “d” was excluded because toe out gait is always happens when there is excessive femoral retroversion. The educational aspect is considered lower order thinking skills since it just needs recalling and some sort of comprehension. The learner just needs some factual and conceptual knowledge to answer the question. The linguistic aspect was not satisfied since the question started with number, and the question body was very short and used the term excessive anteversion without using the adjective “femoral” which left the test taker lost to guess what did the academic mean by excessive anteversion. The formative aspect was satisfied.^[1,26]

Q₇: Patient with acute alcohol intoxication will have the most difficulty with:

- a) Jumping in place with both feet
- b) Jumping forward with both feet
- c) Walking on level surface with heel to toe gait and maintaining his balance
- d) Walking on the stairs

Comments:

The correct answer is (c) since patients with alcoholic intoxication are always having the most difficulty with the tasks that require balance and coordination skills.^[3]Regarding the SELF evaluation process, the scientific soundness of the stand- alone MCQ could not be established regarding options “a”, “b”, and “d” since there is no original research work to support that and the academic is just relying on anecdotic data.²⁶⁻²⁸ The educational aspect of the question was satisfied since it covers the analysis- synthesis spectrum of Bloom’s taxonomy.⁴⁻⁸ The question and its answer options reflect lower order thinking skills that require recalling of data of intoxicated patient. The included physical assessment tests could help in developing learners’ competence.^[22-25] The question has covered factual and some conceptual knowledge. Linguistic aspect of the question was satisfied.^[1]The formative aspect of the question was not established since the academic has included lengthy answer option which is more likely to be the correct answer. The less capable test takers are more likely to choose the lengthy answer by guessing without having the competence to choose the answer. The academic should have used the same answer length or at least two short and two lengthy answers.^[1,2]Moreover, the question does not exactly reflect course and program objectives. The question communicates a less common neurologic case within the Saudi society. Physical therapists and rehabilitation professionals are less likely to encounter such case in their everyday practice.

Results

Discrimination and difficulty indices:

Discrimination index is a measure used to differentiate how more capable learners are doing versus less capable learners on a particular question. Difficulty index is a measure of item difficulty. It is simply the percentage of students who were capable to answer the test items correctly in a given test. The higher the difficulty index values the easier the tested item. Readers should know that a discrimination index of 0.2 and above is desirable. The difficulty index close to 0.5 is considered of medium difficulty and is desirable.^[29-31]The discussed questions within this educational paper had the value of its difficulty index and discrimination index included in the template created by Dr. El-gohary. (Appendix 1).

Appendix 1:

Examiner's Name:

Date:

<i>Difficulty Index & Discrimination Index</i>											
Subject Title:											
Subject #:											
Discrimination Index	Difficulty Index										
	HARD (0- 0.29)				MEDIUM (0.30- 0.79)				EASY (0.80- 1)		
	<i>Question Numbers</i>										
<i>Poor</i> < 0.1	Q5								Q6 Q7		
<i>Fair</i> 0.1 to 0.29					Q1 Q2 Q4						
<i>Good</i> > 0.30											
To be avoided				Acceptable				Good			

NB. Discrimination index of ≥ 0.2 is desirable and difficulty index around 0.5 is also desirable.

Discussion:

Numerous stand alone and short case scenarios MCQs were fully discussed. The MCQs is considered the gold standard for testing knowledge acquisition.^[1,24,25,27,28,32] The author has successfully elucidated the SELF evaluation process through discussing practical examples that have covered a wide array of pathomechanical disorders. The SELF evaluation process is simple, logic and comprehensive to guide academics to create and develop robust MCQs that covers the whole spectrum of thinking skills with emphasis on the higher order thinking skills. SELF evaluation process of the MCQs could be seen as evaluation algorithm for test creators.

Dr. Elgohary has defined the clinical- medical algorithm¹ and for the purpose of this educational article, the algorithm definition will be modified to suit the educational nature of the paper. Educational algorithm is defined as: a systematic approach to guide academics to create and develop high quality MCQs exams within their respective fields. The author recommends using the ten points checklist that was originally published by Dr.El-gohary to create and develop high quality MCQs.^[1]Finally, to advance our profession academics should continuously develop their academic skills to enhance learners' critical thinking skills.^[1,2,33] MCQs exams must be designed to test learners' competence and capabilities in the way that allows filtering out less capable learners and test takers.^[1,2,22,23]

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