

E-ASSESSMENT IN MEDICAL EDUCATION

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***Abstract:** In education, assessment is a continuous process which may perform numerous functions, such as diagnosing, supporting, motivating, controlling or summarising. As a continuous process, assessment takes time, and therefore, where possible, it is replaced by e-assessment. In medical sciences, theoretical knowledge is often assessed using electronic tests based on multiple choice questions. However, the method of preparation to this type of exams and the mere filling of the test form may be problematic for students. Given the above, the authors have decided to monitor the students' approach to the online tests in order to eliminate or correct any arising problems. This document presents the results of surveys taken in the academic years 2014/15 and 2015/16.*

In addition, the article shows the role of formative and summative evaluation in e-assessment as well as the need to apply standards for the development of assessment tools and systems. Even with many advantages, the e-assessment is still rarely used, mainly due to a large load of work and measures at the first implementation stage, as well as the lack of preparation of the academic staff. Therefore, in the authors' opinion, the popularisation of good practices may contribute to improvements in this field.

Keywords: assessment, e-assessment, summative assessment, formative assessment, medical education, MCQ exams, e-examination, e-assessment standards, distance education

INTRODUCTION

Assessment has always formed an integral and important part of education, particularly in formal education. Presently, assessment is not limited to the final evaluation issued at the end of the course (summative assessment), but may play a monitoring and controlling functions in the education process (Boud 2000). As this is a repetitive and time-consuming process, it more and more often takes the electronic form, especially in academic education. In this case, we talk about e-assessment.

Robert Clarisó (Caballé, Clarisó 2016: 73) define the e-assessment as:

e-assessment, which is also known as online assessment, is the continuous electronic assessment process where information and communication technology is used for the presentation of assessment activity, and the recording of responses.

Crisp (2007) classifies the e-assessment into diagnostic, summative and formative assessment, based on the learning stage where the evaluation is conducted. Diagnostic test is a test that evaluates the current knowledge prior to taking the course, which allows to establish the requirements and the scope of educational activities for a particular student. Formative assessment is used as support in the teaching and learning processes. It provides teachers and students with information on the students' current achievements as well as their strengths and weaknesses. Furthermore, the information is provided in such a form as to determine what the teacher or student should do next in order to improve the process. Formative assessment may also be motivating for students, as it shows their competence level, often against a background of the entire group, which allows them to track their learning progress. Summative assessment is the assessment given at the end of the course to evaluate the students' knowledge or skills and to issue an appropriate certificate.

Formative assessment uses various tools to achieve the teaching goals (Ridgway, McCusker, Pead 2004). Diagnostic and formative assessments may help increase the teaching efficiency. Cook and Jenkins (2010) emphasize the important role of such e-assessment constituents as: immediate feedback, objective evaluation and a wide range of tasks and activities. Apart from the advantages, we can also mention the disadvantages such as: required Internet access or user identification, but the main barrier is still the need to educate the academic staff in the field of e-assessment.

There are also issues related to the applied software. E-assessment greatly depends on the systems and tools used. Most tools for test creation are based on MCQs (multiple choice questions), true/false, short answer, and fill in the blanks questions (Marriott 2009, Pachler, Daly, Mor, Mellar 2010). They are great at testing your factual knowledge but can't be directly used to test practical skills (Gruttmann, Böhm, Kuchen 2008).

1. E-ASSESSMENT

On the one hand, e-assessment offers a range of benefits in improving the process of learning, and on the other hand – a reduced workload for the teachers and administrators. The main benefits in the e-assessment process include the elimination of time and space restrictions existing in the case of paper or face-to-face exams, as well as time savings during individual monitoring of students. At the same time, the immediate feedback allows for a genuine formative evaluation.

E-assessment usually takes the form of electronic tests. The most popular types of tests include:

- *Placement tests*, which allow to determine the initial level of students' knowledge or skills in order e.g. to classify them into appropriate learning groups.
- *Diagnostic tests*, which have been developed to catch the students' shortcomings during an academic semester or year.
- *Progress tests*, used to establish if the students have mastered the studied material. If not all the results exceed the required threshold, the teacher should determine the reason and try to eliminate it.
- *Achievement tests*, used to check whether the student has achieved the course objectives. Such tests are carried out at the end of the course and cover the entire material. They should be analysed very thoroughly in order to specify the strengths and weaknesses of the syllabus.

E-portfolio is a tool aimed at supporting the students in tracking their own progress. It allows the students to become familiar with their achievements and deficiencies, and enables the teacher to get a full digital image of the student's progress and output. This assessment method is time-consuming for large group but it allows teachers to analyze the progress by comparing the students' initial works with subsequent ones, not only by collating the grades.

1.1 Formative e-assessment

Formative assessment is the most popular in higher education and may include most of the teacher's evaluative methods. This type of assessment is used during the learning process and provides the teacher with information required to adjust

the teaching methods, if necessary (Gage, Berliner 1998: 529). This category includes progress tests and diagnostic tests. Students must be informed of the evaluation results as soon as possible. The method is very well received if the test results are analysed by the teacher, and the style or contents of the course are changed where necessary. This is called *washback effect* (Heaton 1990:16). It is the most beneficial if the formative assessment is a continuous process which, thanks to the teacher's and students' efforts, contributes to the development of the teaching curriculum and to the preparation for the other type of assessment – summative assessment.

Two aspects are important in the formative assessment: appropriate choice of evaluation time and the feedback. This type of assessment may have a large impact on the current method of learning, and feedback may be used to improve the results achieved by the students in the summative assessment (Crisp 2011). Formative assessment allows the students to become more aware of their capabilities and supports self-education.

Black and Wiliam define five key strategies (Black, Wiliam 2009) of the formative assessment process:

- *engineering effective classroom discussion, questions, and learning tasks that elicit evidence of learning;*
- *providing feedback that moves learners forward;*
- *clarifying and sharing learning intentions and criteria for success;*
- *activating students as owners of their own learning; and*
- *activating students as instructional resources for one another.*

Formative assessment affects all the students and may increase the overall level of the group. The authors highlight the importance of timely and constructive feedback, which may positively motivate the students to effective learning (de Bruyn, Mostert, Schoor 2011).

1.2 Summative e-assessment

The main difference between the summative and formative assessments lies in their objectives. The goal of the summative assessment is to give a value, and therefore it is often quantitative, while the formative assessment is qualitative. Sometimes it is used in the middle and/or at the end of the learning period, to determine the degree in which the curriculum has been realised. Examples of such assessment may be electronic achievement tests or final exams. Summative assessment plays an important role in the determination of the final grade for a given subject/course, and at some universities it may constitute even 60% of the credit. Both assessment categories (summative and formative) are essential and complementary to each other. If the summative assessment proves that the majority of the group did not achieve the level established by the teacher, it means the formative assessment had not been planned in an appropriate manner (Heaton 1990). For this reason, the diagnostic tests should not be conducted at the very end of the semester; otherwise

it will be too late to introduce any changes to the teaching process. Many academic teachers forget about the role of formative assessment in education, focusing only on the summative assessment.

1.3 E-assessment standards, systems and tools

Similar to e-learning, in the e-assessment it is important to have the possibility of exchanging data, share the resources and cooperate between different education systems. A range of standards have been developed to achieve this. The conformity with standards at the stage of planning and implementing the tools and systems ensures their interoperability, reusability, accessibility and durability in e-learning and e-assessment systems. To date, many standards and specifications have been developed, which (to a smaller or larger extent) were implemented in common practice. For example, LOM (Learning Object Metadata), SCORM (Sharable Content Object Reference Model), IMS QTI (Question and Test Interoperability), IMS LIP (Learner Information Package), IMS LTI (Learning Tools Interoperability) are recommended for e-assessment systems. Let us focus on two popular standards.

SCORM is a collection of standards and specifications designed by ADL (Advanced Distributed Learning Initiative, <https://www.adlnet.gov/adl-research/scorm/>). Educational material along with metadata is archived in a single file (format ZIP), which enables automation of the publishing process. Contemporary LCMSs (Learning Content Management System) use integrated procedures for unpacking the ZIP file, and then activate their own modules for metadata analysis and materials presentation based on the analysis result. The SCORM standard also includes tests contained in the package. The LCMS database receives the total score obtained by the student by marking the correct answers. It is a simple and interesting opportunity to transfer ready, closed tests between different LCMS applications (Bohl, Scheuhase, Sengler, Winand 2002). No additional adaptation is required. At the same time, it should be noted that the SCORM content interpretation modules automatically format a range of graphic layout components, and therefore the teaching material may look differently in various LCMS version.

IMS QTI is a standard of sharing the tests and data acquired in the e-assessment process. It defines the data structures which guarantee the interoperability between questions and tests systems (IMS Question & Test Interoperability Specification, <https://www.imsglobal.org/question/index.html>). Furthermore, QTI version 2.0 allows for the creation of different types of questions, such as: multiple choice, ordering, association, union, fill in the blanks, essays, hotspots, object positioning, and painting. The use of XML to describe the tests enables their use on different types of equipment, such as: desktop computers, laptops and other mobile devices. The use of tools supporting the standards is necessary to integrate the e-assessment systems with the LMSs (Learning Management Systems).

The main objective of the e-assessment systems is to monitor the student's learning progress. The system must enable evaluation using different types of questions, immediate feedback, automatic assessment, calculation of weighted average grade, quiz customisation, statistical analysis of the results, reduction of fraud risk by randomizing the questions, and the use of timers. Such systems are mainly developed in academic centres and they are usually not open-source tools. Examples of assessment systems:

ACME is a web-based e-learning tool developed by the University of Girona targeted towards formative assessment, improving the teaching and learning of mathematics studies in Industrial Engineering and Engineering. The system is not an open-source tool (Caballé, Clarisó 2016:77).

TRAKLA2 developed using Java by the Department of Computer Science and Engineering in Helsinki University of Technology. The system is an environment for learning data structures and algorithms using simulations, which can be automatically graded (Caballé, Clarisó 2016:78).

Additionally, there are many different types of tools being useful in the e-assessment process in distance learning, e.g.: SCHOLAR (Heriot-Watt University. SCHOLAR <http://courses.scholar.hw.ac.uk/vle/scholar/session.controller?action=home>), Moodle Quizzes (Moodle, <https://moodle.org/>) or Hot Potatoes (Hot Potatoes, <http://hotpot.uvic.ca/>). Each of them realises one or more of the mentioned testing methods.

2. E-ASSESSMENT IN MEDICAL EDUCATION

In medical sciences, the assessment and e-assessment processes often use tests based on multiple choice questions (MCQ). Such an examination method is perfectly fit for the verification of theoretical knowledge, is unbiased (the questions are evaluated by the computer, so there is no risk of favouritism), and the selection of the right answer is quick and unambiguous. However, MCQ exams may not be directly used to verify practical skills, such as communication with the patient.

2.1 MCQ exams

A common mistake made by the students preparing for the MCQ exams is their conviction that they are memory tests, i.e. that it is enough to remember a given scope of material and to memorise it during the exam. Such tests may also verify the ability to interpret information and apply the acquired knowledge, both in typical and untypical medical cases. Thus, to perform well at an MCQ test, it is not sufficient to memorise the contents of the lesson or handbook.

The Internet offers a lot of advice, and even entire courses which teach how to prepare for an MCQ exam and MCQ exam answering technique. Here is a model list of guidelines taken from the course *How to succeed at MCQs*

(<http://www.mondofacto.com/study-skills/exams/how-to-succeed-at-mcqs/02.html>):

1. Revise everything, and don't try to 'question spot'. MCQ exams can cover an awful lot of material - that's the point.
2. Make sure your knowledge is sufficiently specific. MCQs can be highly specific, so a general knowledge of an area might not be enough.
3. However, a good broad knowledge is helpful when attempting to deduce the correct answer to a question you're unsure of.
4. Practice, practice, practice and then do some more practice. Gather together as many questions as you can lay your hands on.
5. Make sure your practice MCQs cover material that's relevant to your course; there's no point in learning things you won't be asked.
6. Pile on the pressure by practising under exam conditions. This will help you become accustomed to answering questions against the clock, and allow you to accurately judge how much time you can allow for each question.
7. If you try to recreate exam conditions when you practice, you'll find your memory will be triggered under similar conditions in the exam hall.
8. Revise the things you don't know. Sounds obvious, but you're actually more likely to spend time on topics you already know - it's more fun and can be better for morale. Be brave, and tackle your weakest areas (neurology?!) first.
9. Revise with friends; it's easier to stay motivated - and much more fun! You can share knowledge this way too. Make sure you revise with friends of a similar ability - there's nothing more depressing than finding everyone else knows more than you do. Alternatively, if you relish a challenge, try revising with the best and brightest - they may inspire you to raise your game.
10. On the day of the exam, make sure you're clear about the exam format: how many questions are there? How long have you got? Will there be negative marking?

2.2 Motivation

Guidelines 4, 6 and 7 prove the important role of the self-assessment tests in the preparation for the exams. The authors' experience shows that the medicine students of Poznan University of Medical Sciences do not fully seize the opportunity to learn using the self-assessment tests, though their influence on the final exam results is noticeable (Kołodziejczak, Roszak, Ren-Kurc, Bręborowicz, Kowalewski 2015: 217-223). To find the reasons for this and

to determine the students' approach to the e-exams, the authors decided to conduct regular surveys. The results of a two-year study, carried out at the Pathophysiology Department of Poznan University of Medical Sciences in the academic years 2014/15 and 2015/16, are presented in chapter 3.

3. E-ASSESSMENT IN THE OPINION OF MEDICAL STUDENTS

3.1 Background

At Poznan University of Medical Sciences, the subject of pathophysiology for the second year of the medicine course is conducted with the blended learning method, using the online course. The access to materials available at the e-learning portal is opened for the students a week before the course begins and expires after it is completed. The portal offers the contents that support stationary classes and lectures as well as self-learning materials. They include lectures with the teacher's voice comments, clinical cases to be studied before the stationary seminars, and self-tests. The learning materials available on the portal are divided into 10 content-related blocks being consistent with the schedule of stationary classes. The subject concludes with an exam conducted via the e-learning portal.

The pathophysiology students may use a range of electronic revision tests that allow them to verify their level of knowledge before each of the 3 stages: initial physiology test, seminar completion assessment and final examination.

The electronic tests for the pathophysiology course are composed of multiple choice questions. The self-tests consist of 15 or 30 questions and feature a limited completion time. Students may fill the same tests maximum 5 times, and the questions are each time drawn randomly from the database.

Upon completing the course, the students fill an electronic questionnaire to evaluate the course for the quality, accessibility and usability of the electronic materials, including self-tests, and to list the advantages and disadvantages of studying with the use of the e-learning portal and e-assessment system.

3.2 Participants

The analysis will cover the results of 475 questionnaires filled by the second-year medicine students of Poznan University of Medical Sciences in the academic years 2014/15 and 2015/16.

3.3 Data collection and analysis

The survey data have been collected on the e-learning portal OLAT (Online Learning And Training) and then saved as an Excel spreadsheet. The data were analyzed using the Pearson Chi-square test. Calculations were carried out at statistical significance $\alpha=0.05$ in STATISTICA v. 12.0 from StatSoft. Inc. (Tulsa, USA).

3.4 Results and discussion

In the first place, the students evaluated the benefits of learning with the use of the e-learning course, by answering the following question: “In my opinion, the advantages of this learning method are:”. Most of the options included in this question concerned the e-assessment system provided for the course. The students could choose maximum 3 out of 7 available options. The answer structure is presented in Table 1.

Table 1.

Comparison of the answers to the question worded “In my opinion, the advantages of this learning method are:” in the academic years 2014/15 and 2015/16.

Variant of the answer	Academic year	Academic year	p value
	2014/15 n=245	2015/16 n=230	
Possibility of learning at any place and time	73%	75%	0.663
Possibility of checking the current level of knowledge using the self-tests, which motivates me for further work	49%	40%	0.051
Immediate result obtained upon test completion	44%	59%	0.001
Possibility of practicing in the conditions and using the materials similar to the ones given at the completion assessment tests/exams	42%	32%	0.020
Possibility of verifying errors by subsequent attempts taken at any time after filling my knowledge gaps	30%	23%	0.096
A random, personal set of questions	13%	5%	0.005
I do not see any advantages	< 1%	0%	0.302

Source: own elaboration

Students of both years have mostly appreciated the possibility of studying at any place and time. Significant differences ($p < 0.05$) in their replies have been found for the following options: “immediate result obtained upon test completion”, “possibility to practice in the conditions and using the materials similar to the ones given at the completion assessment tests/exams” and “a random, personal set of

questions”. The latter option, i.e. the random set of questions, has aroused the strongest emotions among the students during final exams and partial assessment tests. The survey has shown that the 2015/16 year students would prefer to have the same questions for all of them, as this would give them a stronger feeling of justice. This is the reason why the grade given to this option as an advantage was lower.

Similarly, the students have assessed the disadvantages of studying with the learning portal. By answering the question worded “In my opinion, the disadvantages of this learning method are:”, they could mark maximum 3 options. The answers are compared in Table 2.

Table 2.

Comparison of the answers to the question worded “In my opinion, the disadvantages of this learning method are:” in the academic years 2014/15 and 2015/16.

Variant of the answer	Academic year	Academic year	p value
	2014/15 n=245	2015/16 n=230	
Too few possible attempts to each test	25%	10%	< 0.0001
The time for filling the test is too short	3%	1%	0.160
I do not like this type of assessment – a poor result demotivates me	2%	4%	0.245
I do not like learning under time pressure (a fixed deadline for taking the test prior to the final assessment test and exam)	17%	24%	0.079
Impossibility of consulting / clarifying any doubts regarding the correct answer to the questions included in the self-test	84%	80%	0.335
The test contains too many questions	< 1%	2%	0.327
I do not see any disadvantages	9%	10%	0.682

Source: own elaboration

The evaluations of the disadvantages of learning with the portal were similar, and the only difference resulted from the fact that in the academic year 2015/16 the number of attempts to take each available self-test was increased. The most significant disadvantage indicated by the students of both years was the

impossibility to clarify their doubts related to the choice of a correct answer. As mentioned above, the need to provide feedback is very important in the formative assessment, which is proved by the students' expectations. The fact that they could verify if their answer was correct appeared to be insufficient.

As during the pathophysiology course, all the assessment tests, exams and self-tests are electronic and include multiple choice questions, the students are also asked about the advantages and disadvantages of such an evaluation method. Similarly to the previous years, the students could choose maximum 3 options. Table 3 presents the answers to the question “I liked the test in the electronic format because...”.

Table 3.

Comparison of the answers to the question worded “I liked the test in electronic format because...” in the academic years 2014/15 and 2015/16.

Variant of the answer	Academic year	Academic year	p value
	2014/15 n=245	2015/16 n=226	
Time of the test measured individually	33%	36%	0.466
The same time for everyone	22%	26%	0.3020
I know my results immediately	94%	92%	0.434
A random, personal set of questions	7%	2%	0.023
I see a clear list of questions and I can start by selecting the best-known answers	34%	30%	0.330
I can see which questions I have already answered	34%	35%	0.959

Source: own elaboration

According to the students, the biggest advantage of the electronic tests was the immediate information on the result, provided upon completion. The option “a random, personal set of questions” was the least popular advantage, and the arisen difference proves the initial conclusion that the students of the lower year would prefer the same questions for everyone. The structure of answers for the other options is very similar for both analysed groups.

Finally, the comparison of the answers to the question worded “In my opinion, the negative features of the electronic tests are:”. The results are presented in Table 4.

Table 4.

Comparison of the answers to the question worded “In my opinion, the negative features of the electronic tests are:” in the academic years 2014/15 and 2015/16.

Variant of the answer	Academic year	Academic year	p value
	2014/15 n=142	2015/16 n=145	
Unclear way of doing the test	27%	39%	0.024
It is difficult to read the text on the screen	40%	34%	0.265
The computer distracts my attention	29%	25%	0.439
I don't like being assessed by a computer	10%	10%	0.954
You have to be more skilled in doing online tests	29%	24%	0.363

Source: own elaboration

Negative experience with the electronic exams were mostly related to difficulties in filling the test and reading the text on the screen. Until now, students have usually taken tests in the paper form (primary and middle school graduation exam, final exam of secondary education), which makes them less experienced in filling the test on the computer. As we know, it is easier to focus on a paper sheet than to read the text on the screen. Ten percent of the students in the analysed groups do not like being evaluated by a machine, which may surprise considering the fact that it is a way that guarantees objectivity and eliminates favouritism.

Some students have omitted the answer to this question, which resulted in the difference in the number of analysed questionnaires compared to the previous ones. For the authors, it is a guideline that the options in this question should be examined in more detail.

CONCLUSIONS

Assessment is intrinsically linked with the teaching process. Technical progress allows for the automation of activities involving the collection, management and

distribution of tests, which in turn allows the examiners to save time (Ren-Kurc, Roszak 2011; Roszak, Kołodziejczak, Kowalewski, Ren-Kurc 2013: 35-36). In this way, assessment is transformed into e-assessment, which may have a positive influence on the teaching process, adapt it to the demands and capabilities of learners and motivate them to continue their work.

In medical sciences, e-assessment based on MCQ tests is a common practice. Proper preparation to the e-exam does not only involve mastering the theoretical knowledge, but also the possibility to take several training sessions in conditions being similar to the ones at the exam. The feedback obtained from the self-tests may (during revisions before the actual exam) allow to find and correct any deficiencies. It is also important to identify the nature of problems in filling the electronic tests and to eliminate them.

Surveys carried out by the authors prove that students appreciate the benefits of the electronic tests, the most valued being the possibility of obtaining the result immediately after the exam is completed, and the possibility of verifying the current level of knowledge using the self-tests. As results from the comparative analysis, students have an established approach to the advantages and disadvantages of e-assessment, and equal exam conditions provided to all the students even imply the aim to unify the questions.

E-assessment based on highly specialised systems and tools allows the teachers to constantly monitor the students' progress, to control the learning process in order to improve the teaching efficiency, and to attain the educational objectives. In the authors' opinion, e-learning will gradually become more popular, which may be considerably influenced by the popularisation of good practices.

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