

# Analysis of Suitability of Online Assessment by Maintaining Critical Thinking

Mohamed Chabi, Mohammad Shahid Jamil, Mahmoud I Syam

**Abstract**—The purpose of this study is to determine whether paper assessment especially in the subject mathematics will ever be completely replaced by online assessment using Learning Management System and Content Management System such as blackboard. Testing students has moved from the traditional scribbling and sketching on paper towards working online on a screen and keyboard. It is found that online assessment by using selective types of questions like multiple choices, true or false and final answer questions don't reflect the actual understanding of students in solving the problems and teachers can't determine the weakness points of students. In addition, it is showed that OBMCQs are a very good tool for self-assessment and when teachers are testing for knowledge and facts. But when it comes to the skills, OBMCQs are poor tools for measuring the ability to apply knowledge to complex math problem.

**Keywords**—Paper assessment, online assessment, learning management system, content management system.

## I. INTRODUCTION

LEARNING Management System (LMS) and Content Management System (CMS) are very accepted tools in the current environment of teaching which creates a better and pleasant interactive teaching atmosphere. Authors have used Blackboard to analyze and create multiple choice and true/false questions for our study. Blackboard supports online courses and different type of assessments methods. Instructors must know the answer of the following question before setting the student learning outcome.

- What do students need to know in order to be well prepared to graduate from Qatar University?
- Will our method of teaching fulfill student requirements?
- Are we providing adequate knowledge of subject and student become critical thinker and decision maker?
- Are we getting and rectifying proper feedback and comment?
- How will we know that they have learned what we think they should?

In the subject mathematics, the assessment is the exercise of judgment on the quality of students' work, as a way of supporting student learning and appraising its outcomes. Testing students has moved from the traditional scribbling and sketching on paper towards working online on a screen and keyboard. Online assessment in sciences has become more

prominent [3]. Whether paper activities especially in the subject mathematics will ever be completely replaced by online activities is highly unlikely but that online mathematics has come to stay [2]. It is not an easy task to generalize when comparing student performance in two different type of assessments the Online assessment Based Multiple Choices Questions (OBMCQs), which includes multiple-response questions, matching questions, true/false questions and "hot-spot" questions and Traditional Paper Based Questions (TPBQs) that required a constructed response. OBMCQs are very popular at institutions. The purpose is to determine whether OBMCQs test are suitable or not for students. A student who had the right approach to a question, but made a single sign error or misunderstood the question slightly, could lose all points for a question, whereas a student who had no clue whatsoever what to do, and simply guessing randomly, could manage be rewarded for sloppy approaches to problem solving. Minor mistakes and major mistakes are treated equally. Here one question can be raised; do we value correct mathematics or value correct answer?

## II. CONCERN OF MULTIPLE CHOICE QUESTION (MCQ) TO TEST STUDENT OUTCOME

MCQs are used to measure various type of outcome [4] when learner must be able to memorize or recall certain specific facts, learner must be able to understand, rephrase and extrapolate the facts, activities can assist student to apply studied concepts and theory to new problem, ability to analyze and divide problem into small steps/problem so that problem becomes easier, ability to link and complete structure to get ultimate result into diverse appearance and learner must be able review solution of problem.

MCQs measure accomplishment at different levels of learning. Therefore it is a job of examiner to test learner capability. The process is far more important than the answer. MCQs promote that the answer to a mathematical question is more important than the process used to arrive at that answer [1]. The decision to use multiple-choice tests or include multiple-choice items in a test should be based on what the purpose of the test is. In exam setting, one usually wants to have more complex questions that test aspect of the material to separate those who basically understand the material from those who are truly lost.

In this study, authors should not be driven by multiple choices testing into eliminating critical thinking and problem-solving. Students should learn to think and apply knowledge and in this case TPBQs that required a Constructed Response are more suitable. It is therefore important to use a

Dr. Mohamed Chabi is with Department of Mathematics, Foundation Programme, Qatar University, Doha, Qatar (Mobile number: +974 55713990, e-mail: mchabi@qu.edu.qa).

Dr. Mohammad Shahid Jamil was with Department of Computer, He is now Foundation Programme, Doha, Qatar (e-mail: shahid@qu.edu.qa).

Mr. Mahmoud I. Syam is with Department of Mathematics, Foundation Programme, Qatar University, Doha, Qatar (e-mail: mshyam@qu.edu.qa).

combination of both type of questions and this it should be seen as additional assessment approach that emphasizes on enforcing misconceptions “common errors”, when we are testing for the knowledge and facts and Support role in self-assessment for the course, particularly with regards to foundational material whereas constructive response questions are important to check for procedures and critical thinking. Both types of assessment have a place where appropriately utilized.

### III. STUDENTS' PERFORMANCE IN OBMCS VERSUS TPBS

Authors discussed an example of a True/False exam question where student can earn full credit. Authors are presenting an answer book of a student who has solved question Q6b from midterm's exam spring 2012 and manage to get answer. Therefore either student will get full or zero in this answer.

In Fig. 1 shows if the questions was limited to yes or no, student would got a full mark despite he does not know the reason. To determine which format type of questions OBMCS or TPBS is more reliable for testing students on knowledge, facts, problem-solving and critical thinking. An experimental was conducted on pre-calculus students of four different groups in each group of an average 23 student for semester fall 2009, spring 2010, fall 2010 and spring 2012. These students were given two questions and in each question were divided into two different format of questions OBMCS and TPBS.

The experiment was performed during the class time. The students were asked to bring their laptops. After completing OBMCS which took those about 5 minutes, they were given papers to do the second part of the question TPBS.

Q6. (6 points, 3 points each)

(a) Give an example of four ordered pairs of a relation that is NOT a function.

Answer:  $\{(2,1), (3,4), (3,5), (2,6)\}$

(b) Indicate if the following equation represent  $y$  as function of  $x$  (Justify your answer)

$\frac{|y+x|}{|y-x|} = 2$

not function because for example

$|y| \geq 2$   
 $-2 \leq y \leq 2$   
 $-2 \leq y \leq 2$

Student managed to give the right answer "not function" but

He not only failed to justify his answer, he also demonstrated weakness in algebra. If this question was true of false question, he would earn a full credit without knowing why the given equation was not a function.

Fig. 1 Yes/No Question, Student got full mark

The average score of each type of questions appear in Fig. 2 for Question 1 and in Fig. 3 for Question 2.

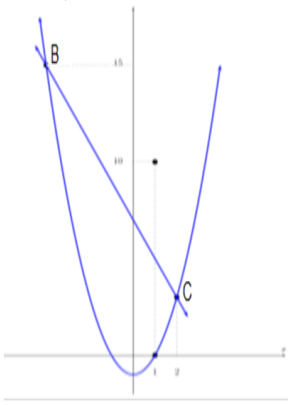
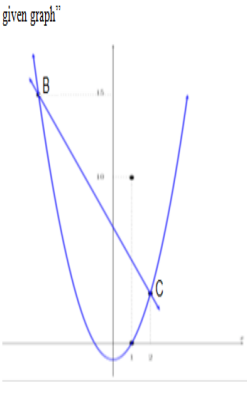
OBMCs	TPBs
The equation of the line L1 that passes through point A(1, 10) and perpendicular to the line L2 that intersects with $y = x^2 - 1$ at points B and C is "See the given graph"	Find equation of the line L1 that passes through point A(1, 10) and perpendicular to the line L2 that intersects with $y = x^2 - 1$ at points B and C "See the given graph"
	
is: a. $x + y = 11$ b. $y - x = 9$ c. $x - 2y = -19$ d. $2x + y = 12$	
Average Mark: 15.7%	Average mark: 40.8% Without Partial Mark: 27.4%

Fig. 2 Average score of each format type of Questions for Question 1

OBMCs	TPBs
The domain of $\frac{f(x)}{g(x)}$ is equal to domain of $\frac{\sqrt{f(x)}}{\sqrt{g(x)}}$ a. True b. False	Given $f(x) = \sqrt{4-x^2}$ , $g(x) = \sqrt{x^2+2x-3}$ and $h(x) = \frac{4-x^2}{x^2+2x-3}$ For what condition on $x$ $h(x) = \frac{f(x)}{g(x)}$ ?
Average Mark: 23.4%	Average Mark: 51.2% Without Partial Mark: 38.7%

Fig. 3 Average score of each format type of Questions for Question 2

Question 1 was designed to test students on Procedures and Critical Thinking. Question 2 was designed to test students on understanding facts, concept and critical thinking. From Figs. 1 and 2 it is clear that there is a significant difference in students' average mark between the two different format of questions OBMCS and TPBS. When partial credits were not allowed, the average mark for Question1 reduced to 27.4% that is two third of students lost partial mark and in the second question 2 the average mark will be reduced to 38.4% that is three quarter of students will lose partial mark. It is clear indication that OBMCS treat minor and major mistakes as equal and do not make provision for partial credit. In an assessment that provided partial credit for partially correct solutions student pass the entire course without ever having

done anything perfectly correctly.

When using OBMCQs is the possibility of guessing in question 2 is 50% chance that student will get the answer right although he may not know the reason why and this will pose serious questions about student's knowledge

Because of nature of critical thinking questions, students had scored poor marks. OBMCQs are unfair and not suitable for questions that required critical thinking [5]. OBMCQ are best used for checking whether students have learned facts and routine procedures that have one, clearly correct answer and for enforcing misconceptions "common errors".

Some examples of questions that students can answer them by guessing but they do mistakes on paper:

- Confusion between  $-x^n$  and  $(-x)^n$  where  $n$  is an even number
- Misinterpreting the law of multiplication  $a \times (b \times c) = (a \times b) \times (a \times c)$
- Cancelling errors: such as
  - Simplifying:  $\frac{a+b}{a}$  to get  $b$  or  $1 + b$
  - Equation:  $4x = x \Rightarrow 4x = 1$
- Additive Assumptions

$$(a + b)^n = a^n + b^n$$

$$\frac{a+b}{c+d} = \frac{a}{c} + \frac{b}{d}$$

$$|a + b| = |a| + |b|$$

- Misuse of Zero Product Property such as
  - $\frac{3+x}{x} = 0 \Rightarrow 3+x=0$  and  $x=0$
  - $x(3x-4)=4 \Rightarrow x=4$  and  $3x-4=4$
- Multiplying Ignoring Powers:  $ab^n = (ab)^n$
- Misconception about the use of square roots
  - Students seem to be under the misconception that  $\sqrt{9} = \pm 3$ . This type of mistake is due to the fact that when solving  $x^2 = 9$  students usually takes the square roots on both sides.  $\sqrt{x^2} = \sqrt{9} \rightarrow x = \pm 3$ .
  - $\sqrt{x} = -1$  usually students square both sides ignoring the fact that  $\sqrt{x} \geq 0$
- Confusion between  $\sqrt{x^2}$  and  $(\sqrt{x})^2$
- Assumption such as if the formula  $\sqrt{ab} = \sqrt{a}\sqrt{b}$  works for multiplication it must work for all  $\sqrt{a+b} = \sqrt{a} + \sqrt{b}$
- When applying Multiplication/Division property of equality on inequality.
  - $\frac{1}{x+1} > \frac{1}{1-x} \Rightarrow 1-x > x+1$
- Misunderstanding the concept of identity when they come to solve
  - $x + a = x + a \rightarrow 0 = 0 \rightarrow x = 0$  Instead of  $0x = 0$  which is identity.
- Confusion between  $x^0$  &  $x \times 0$
- Confusions between  $(f+g)(x)$  and  $f(x+y)$  misinterpreting properties of function.

- Confusion about Inverse notation, thinking that  $-1$  is an exponent  $f^{-1}(x) = \frac{1}{f(x)}$
- Confusion between  $\sin^n(x)$  and  $\sin(x^n)$
- Confusion with the log properties like  $\log^n x = \log x^n$

#### IV. STUDENTS' OPINION, COMMENTS AND PREFERENCES ABOUT QBMCQS

The authors had developed online survey for students' opinion on OBMCQs. About 60 Pre-Calculus students took the survey. Table I represents students' opinions on different categories of question on OBMCQs. It has been noticed in the survey that about 50% students who guessed their answers when it comes to OBMCQs and about 90% of the students required a calculator for the test. Lastly, about 75% of the students did not have any issue with completing the test on time.

TABLE I  
STUDENTS' OPINIONS ABOUT QBMCQS

	Strongly agree	Agree	Strongly Disagree	Disagree	No opinion
OBMCQs are easy	29%	34%	11%	19%	7%
Most of time I guess the answers	21%	26%	16%	18%	19%
I work out the problems first	9%	12%	16%	52%	11%
I read all questions	32%	19%	16%	30%	3%
OBMCQs are good for testing	10%	17%	47%	26%	0%
I start with easy questions	84%	9%	1%	6%	0%
I need a calculator for the test	66%	23%	8%	3%	0%
I prepare well for the test	18%	23%	14%	30%	15%
I have enough time for the test	35%	39%	6%	20%	0%
I am sure of my answers	24%	21%	22%	13%	20%

#### V. STUDENT COMMENTS AND PREFERENCE

Some of the common comment and preference are:

##### A. Students Comments

1. The multiple choice exams very difficult because it gives all the credit to the final answer and no partial credits for the solution which is very important
2. Student can get the correct answer by guessing without even looking at the question and a student who studied hard for the test who made a small mistake will not earn any credit

##### B. Students Preferences

The students' survey and comments gives clear indication that students are not comfortable with the idea of having OBMCQs for assessment. But they liked the fact that they can get their grade just after completing the exam directly, unlike the traditional method that required writing for human to mark the test.

#### VI. FINDING AND CONCLUSION

The decision to use multiple choice questions in a test should be based on what is the purpose of the test and what skills are teachers looking for to measure. Teachers should not

be driven by multiple choices testing into eliminating critical thinking and problem-solving.

The multiple choice questions are good tools for Enforcing misconceptions “common errors”, when students are tested for the knowledge and facts, Support role in self-assessment for the course.

OBMCQs are best used for checking whether students have learned facts and routine procedures that have one, clearly correct answer [6].

Students should think then apply knowledge, facts and procedures which are necessary for thinking.

Multiple choice questions don't reflect the actual understanding of students in solving the problems.

Students apply what they learned by working through problems using pencil and paper. The process of solving a problem is more important than to getting answer.

#### ACKNOWLEDGMENT

This publication was made possible because of the support of Qatar University. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Qatar University.

#### REFERENCES

- [1] A. M. Pascarella, The influence of web-based homework on quantitative problem-solving in a university physics class paper presented at the National Association for Research in Science Teaching, Vancouver, BC, Canada, 2004 <http://lectureonline.cl.msu.edu/papers/204416ProceedingsPaper.pdf> (accessed August 2007).
- [2] J.E. Bartlett, K.A. Reynolds, M.W. Alexander, A tool for online learning. *Journal of Online Learning*, 11(3 & 4), 22-24. 2000.
- [3] M. Alexander, J.E. Bartlett, A.D. Truell, K. Ouwenga, Testing in a computer technology course: An investigation of equivalency in performance between online and paper and pencil methods. *Journal of Career and Technical Education*, 18 (1), 69-80. 2001.
- [4] M.J. Bresciani, C. L. Zelna, J. A. Anderson, Assessing Student Learning and Development: A handbook for practitioners. NASPA 2004
- [5] Neşet Demirci. a University Students' Perceptions of Web-based vs. Paper-based, Homework in a General Physics Course, *Eurasia Journal of Mathematics, Science & Technology Education*, 2007, 3(1), 29-34.
- [6] S.W. Bonham, D.L. Deardorff, R.J. Beichner, Comparison of student performance using web and paper-based homework in college-level physics. *Journal of Research in Science Teaching*, 40, pp-1050–1071, 2004.