Journal of Engineering Education Transformations ,
Volume 31 , No. 4, April 2018, ISSN 2349-2473, eISSN 2394-1707

Multi-Facet Evaluation of Under-Graduate Engineering Students by Taxonomy based MCQTest

Mihir Velani[1], Mayuresh Dave[2]
[1,2] Department of Electrical Engineering, RK University, School of Engineering, Rajkot
[1]mihir.velani@rku.ac.in
[2]mayuresh.dave@rku.ac.in

Abstract: Assessment of students has always been a difficult task for faculties, particularly when it is an engineering domain. It is observed that in recent scenario, typical written exams are not worthy to conduct as they do not offer sufficient flexibility to evaluate students; flexibility in terms of assessing promptness of attempting variety of questions. Therefore, here an attempt has been made with a taxonomy based an onlinemultiple-choice question-MCQ test for a subject- High Voltage Engineering at RK University. In the present work, the categorization of questions is again a reconsideration of Bloom's taxonomy: Cognitive domain, Affective domain, Psychomotor domain. In the aforementioned subject, a wide spectrum of questions was assigned to the students. It comprises questions with mathematical calculations, illustration and circuits, and reasoning. The objectives of this trial were not only to evaluate the mass of students who attempted a particular set of questions but also to analyze the response of these attempts. This also provides an insight about the proficiency of students. Besides, the paper encompasses the justifiable arguments for the results of the examination by stating the probable causes and effects of it. In the later stage of it, the remedies are also suggested to improve the performance of such examination. Further, certain merits and demerits of the opted mode of examination are also discussed.

Keywords: Assessment, Affection, Cognition, Psychomotor, Taxonomy.

Mihir Velani
Department of Electrical Engineering, RK University,
School of Engineering, Rajkot
mihir.velani@rku.ac.in

1. Introduction

Evaluation of students' accomplishment in a pre-defined curriculum is a crucial task as it decides the learning status in the education environment. A comprehensive assessment becomes even more essential when it is connected to engineering field.

The innovations in both engineering and science [1] can bring new technological solutions to the broader society and have the potential to change the world eventually. Therefore, it is highly recommended to analyze conceptual and concrete aptitude of engineering students as they can play a key role to raise the living standards for a growing world population.

To address the same, an attempt has been made through an MCQ based online web test for 8th semesterelectrical students at RK University. The MCQ test has certain distinctive advantages such as it offers quick and accurate results and statistics [2-3]. In contrast, it mandates an organized questionnaire and considerable time to put forward [2-3]. The MCQ is the most preferred mode of examination in recent times not only in academic and competitive exams but

also to evaluate trainees in professional culture. In recent times, worldwide, majority of the competitive testsare being conducted through MCQ with a wide range of questions with a view to evaluate students' aptitude in various learning aspects [4-5]. Besides, it was also intended to assess a student for cognitive domain for his/her competency of lower order thinking skills to higher order thinking skills [6-10]. In the affective domain, it was expected to rate a student for a receiving phenomenon to characterization by value set [10]. Away from it, it was emphasized to examine a student extending from imitation behavior to naturalization conduct in the psychomotor domain [10]. Therefore, it is an initiative to analyze students' fitness towards the mode of exam. The paper entails a discussion on questionnaire pattern, response of students to a specific set of questions, challenges faced from both students and examination panel and inadequacies of the mode of the analysis. The examination was conducted for theoretical continuous internal evaluation (TCIE, (April 2017)) component-II entitled for a subject-High Voltage Engineering (EL903).

The paper organization of the paper is as below:

The section II incorporates questionnaire pattern and relevant details, and analysis of outcomes. In section III, the authors have made efforts to find out the possible causes for both the failure and the inadequacies face throughout the examination process and have suggested suitable remedies in order to improve the overall performance of the system. In the present work, the psychological stress and other intellectual factors have been considered as immeasurable and therefore excluded in the analysis.

2. Pattern of Questionnaire

The examination was conducted for 5 different batches of 20 students in eachby means of an online web tool- edmodo.com. The batches may have heterogenous qualities; here it is not considered for sake of avoiding complexity in the analysis. Theeducational webtool offers a great deal of flexibility in regards to set questionnaires and their order of attempt. Besides, it generates all-inclusive statistics. The test was divided into two sections weighing 40 marks extreme with time limit of 1-hour duration irrespective ofthe individual attempt. The level of the Bloom's taxonomy is created in reference to the observation of the information to the recognition of the subjectivity. The selection of Bloom's taxonomy (in both set-I and set-II) is categorized to fulfill the course learning outcomes(CLOs) of the subject; the overall level of the taxonomy remains identical in both the sets. The questionnaire contains a wide range of problems for instance, numerical calculations, graphical representations, electrical schematics, logical reasoning and rememberingresponse.During the evaluation, NO negative gradingswere measured. The accommodation of the questions can be referred in Table 1.

The statistics provides information on performance of batch in context to percentage pass and percentage fail and can be studied from Fig.1 to Fig. 5 for respective question sets.

For the sake of brevity, only striking features of the statistics have been discussed. The statistics for all the batches show that a large disparity is observed in both the question sets. In the batch-1, approximately half of the students successfully attempted numerical questions in the question set-1 whereas the result was 30% in question set-II. The scenario is completely different in rest all the batches (Fig. 2 to Fig. 5).In the cognitive domain, batch-2 (see Fig. 2) has shown a balanced performance in both type of question sets as compared to other batches in the same category. In the

Table 1. Questionnaire Design

Framework of the test			
Question Modules/ Sets	**Sub Questions**	**Max. Marks (each)**	**Total Marks**
Question-I	10	2	20
Question-II	20	1	20
Total Marks			40
Broad Spectrum of the questionnaire			
Question type (Taxonomy)		**Question-I**	**Question-II**
Numerical (Cognitive domain)		3	1
Graphical Representation (Psychomotor domain)		1	2
Electric Circuits (Affective domain)		1	2
Logical Reasoning (Cognitive domain)		0	6
Remembering (Cognitive domain)		5	9
Total Questions:30		10	20

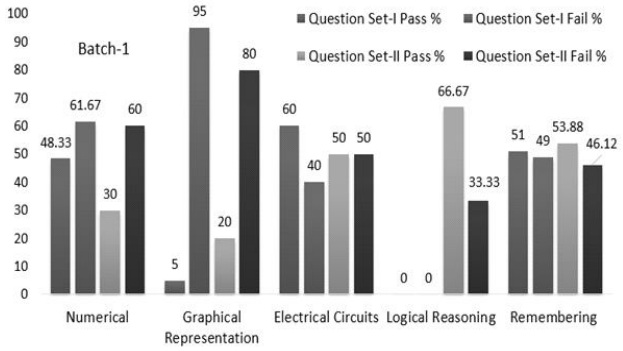

Fig. 1 Statistics for Batch-1

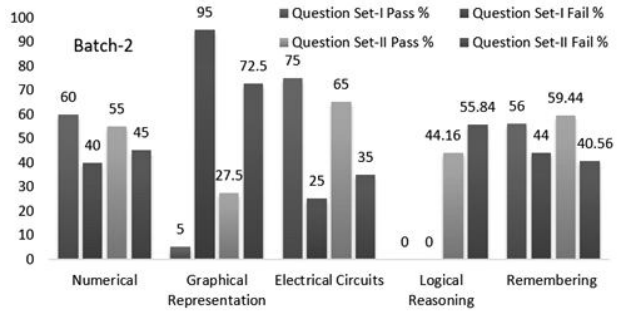

Fig. 2 Statistics for Batch-2

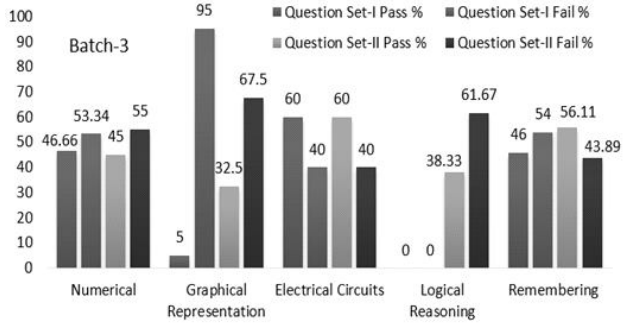

Fig. 3 Statistics for Batch-3

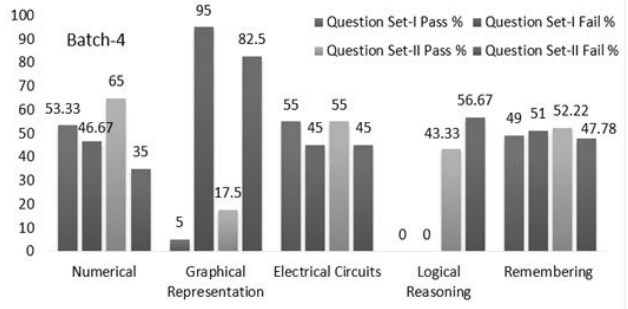

Fig. 4 Statistics for Batch-4

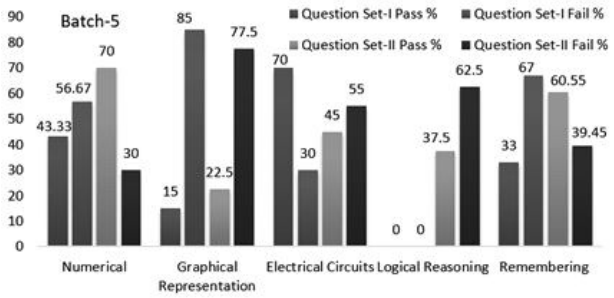

Fig. 5 Statistics for Batch-5

psychomotor area, the students were expected to construct an idea from the graphical representation and execute the data, but it was huge setback that only 15.7 % students on an average were effective in both the question sets. The students of batch-3 and 4 showed a steady performance while attempting questions comprised of electrical circuits. These can be referred from Fig. 3 and Fig. 4 respectively.

These receiving and responding phenomena vary in the rest students. Batch-1, on the other side, showed a remarkable cognition towards the question set-2. However, batch-3 and 5 exhibited a lack of confidence in the same set of questions. For another type of cognitive questions, it is interesting to note thatthe students showed a varied performance up above 50% to 60% in batch-1 to batch-4 respectively, but the statistics are not agreeable. By considering both question sets with taxonomy, the overall performance of all the batches is a huge disappointment. These statistics can be referred from Table 2. A sample of each taxonomy should be referred as below. The correct choice has been indicated by BOLD letters.

A. Numerical Question (Cognitive domain):

1. 15-stage impulse voltage generator has a capacitance of 0.15 μF and a charging voltage of 200 kV. The energy rating in kJ is-

a. 40

b. 45

c. 670

d. 170

Table 2. Overall Statistics

Question type (Taxonomy)	Mean of Question-I& Question-II	
	Pass%	Fail%
Numerical (Cognitive domain)	51.66	48.34
Graphical Representation (Psychomotor domain)	15.5	84.5
Electric Circuits (Affective domain)	59.5	43.5
Logical Reasoning (Cognitive domain)	39.33	60.67
Remembering (Cognitive domain)	51.72	48.28

B. Graphical Representation(Psychomotor domain):

1. Consider a typical long transmission line of 300 km of 400 Ω surge impedance. A pictorial view can be imagined as the figure displayed. A direct stroke with a lightning stroke current as low as 10,000 A occurs over one of the phase conductors. In such situation, what amount of over voltage could be caused?

a. 13333.33 kV

b. 2000 kV

c. 4000 kV

d. 20,000 kV

Fig. 3 A Pictorial View of a Typical Long Transmission Line with a Direct Lightning Stroke

A. Electrical Circuits(Affective domain):

1. Refer the attached circuit for the measurement of ripple voltage. Identify the equation that measures the correct value of ripple voltage.

a. $V2(t) = V1(t) - Vdc$

b. $V1(t) = V2(t) - Vdc$

c. $Vdc = V1(t) + V2(t)$

d. $V2(t) = 2\,V1(t) - Vdc$

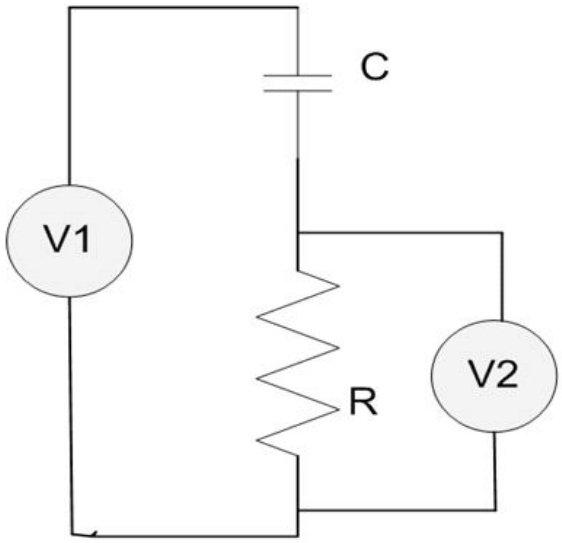

Fig. 4 Measurement of Ripple Voltage

A. Logical Reasoning(Cognitive domain):

1. Following are certain conditions that incur dielectric loss in the insulator: You need to identify their contribution by one or more conditions - I. Conduction loss by ionic conduction II. Polarization loss by orientation boundary conduction II. Ionization loss by partial discharges.

a. I only

b. II only

c. II only

d. All of them

B. Remembering (Cognitive Domain)

1. One of the following lightning strokes has a least probability to reach to the earth-

a. Dart ladder

b. Return Stroke

c. Pilot Streamer

d. Stepped ladder

2. Probable Causes And Inadequacies With Taxonomy Mcq Test

It is clearly evident that the overall result is not much convincing in each set of modules and in respective domains. In both sets of questions, around 50% students were observed to be comfortable with numerical answers. To improve upon, the students are needed to be involved in more mathematical practices with wide range of analytical variation. While in case of the questions comprised of graphical representation entangles the participants that indicates the lack of imaginative ability and interpretation. This could however be developed by bringing modern regimes into the classroom and lab sessions for instance, usage of multimedia and digital classroom, by allotting creative assignments, and involving rigorous computer simulations. The same may be precisely organized with assignments with complex electrical circuits. On the other side of it, remembering part of cognitive domain is found considerably stress-free. To this, appropriate delivery of contents and factual assimilation of ideas are anticipated. Nevertheless, an MCQ with online support system does offer immediate results with flexible statistics, but it is not expected to scan true potential of the individual; the candidate may have a random guess to choose a choice by viewing half and half opportunityif no negative considerations are entitled. Moreover, the mode of assessment does not give an opportunity to review a written competency of a candidate but it ensures the promptness of a student towards a set of questions with Bloom's Taxonomy.As long as the questionnaire [11-12] is related, one needs to deliberately involve in a structured and a closed draft so as to assess an accurate potential of respondents. It should be further noted that educational activities are to be fostered with Bloom's Taxonomyof leaning domains for higher forms of intellectual in education [13].

3. Conclusions

In general, the MCQ test proposes a quick assessment with eye-catching errors. Additionally, the results cannot be granted for each mass of students. But, as a preliminary measure, the test can be proven a striking tool for evaluating the existing students. Henceforth, it is suggested to evaluate students further with a comprehensive questionnaire incorporating different taxonomy for effective learning.

4. References

[1] A Aeschlimann, R Westkaemper,M Doherty,A D Woolf (2001), Multiple choice question quiz: A Valid Test for Needs Assessment in CME In Rheumatology and For Self-Assessment, BMJ Journals, Ann Rheum Dis 2001;60:740–743.

[2] Tim S Roberts (2006), The Use of Multiple Choice Tests for Formative and Summative Assessment,8th Australasian Computing Education (ACE2006), Australia, Conferences in Information Technology, Vol. 52.

[3] Faculty Focus (2015), Advantages and Disadvantages of Different Types of Test Questions, Higher ED Teaching Strategies from Magna Publications [Online]. Available at:<https://www.facultyfocus.com/articles/educational-assessment/advantages-and-disadvantages-of-different-types-of-test-questions/>, 9th Jun 2017.

[4] Moss E (2001), Multiple Choice Questions: Their Value as an Assessment Tool, US National Library of Medicine, National Institute of Health, 14(6):661-6.

[5] UNSW Sydney (2017), Assessing by Multiple Choice Questions [Online]. Available at:<https://teaching.unsw.edu.au/assessing-multiple-choice-questions.

[6] Lorin W. Anderson, David R. Krathwohl; et al (2001),A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives, ISBN-13: 9780801319037, , Pearson Publications, Section-II, Chapter-5.

[7] Richard M. Felder, Rebecca Brent (2004), The ABC's of Engineering Education: Abet, Bloom's Taxonomy, Cooperative Learning, and So On, Proceedings of the American Society for Engineering Education Annual Conference & Exposition, Session 1375.

[8] Heather M Bush, Jennifer Daddysman, and Richard Charnigo (2014), Improving Outcomes

with Bloom's Taxonomy: FromStatistics Education to Research Partnerships, J Biomet Biostat ISSN: 2155-6180 JBMBS, an Open Access Journal, Volume 5, Issue 4.

[9] Arthur James Swart (2010), Evaluation of Final Examination Papers in Engineering: A Case Study Using Bloom's Taxonomy, IEEE Transactions on Education, Vol. 53, No. 2.

[10] Nancy E Adams (2015), Bloom's taxonomy of cognitive learning objectives, Journal of Medical Library Association, vol.103(3).

[11] Saul McLeod (2014), Questionnaires, Simply Psychology [online]. Available at:<https://www.simplypsychology.org/questionnaires.html>.

[12] Susan E. Wyse (2014), The Importance of Questionnaire Structure, blog in Snap Surveys [online].Available at:<https://www.snapsurveys.com/blog/importance-questionnaire-structure/>.

[13] Donald Clark (1995), The Performance Juxtaposition Site [online]. Available at: <http://www.nwlink.com/~donclark/hrd/bloom.html>.