

A study of Selected-Response Type Assessment (MCQ) and Essay Type Assessment Methods for Engineering Students

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Abstract : In the field of education, students' assessment provides important data on the knowledge, skill, attitudes, and beliefs of students which are used to refine programs and improve student learning. With the help of assessment data, a teacher can track students' progress, plan his/her lessons more effectively and can also motivate his/her students by providing an accurate measure of his/her progress. Assessment can be done by using many methods such as multiple-choice question-based test and essay or short answer type test, etc. Whichever assessment method is used, it should enhance student learning in relation to educational goals. Assessment should correctly evaluate students' performance against curricular goals. The present research paper analyzes the two popular methods of assessment in India which are Essay/short answer type assessment and Multiple-choice question-based assessment. A small study was conducted on 108 students of Bachelor of Technology 8th Semester (IV Year) in order to investigate the two methods. The group of students was examined by using Essay type method and MCQ type method in TCIE-1 and TCIE-2 respectively for the same subject which is power system design. Wilcoxon signed rank test was applied using MATLAB to test the hypothesis of significant difference between scores of students in these two assessments. Moreover, correlation coefficient was

also calculated to prove that students require a different skill set to secure good marks in these two methods. So, these two methods should be used to address different assessment purposes.

Keywords : MCQ, Essay/short answer type test, TCIE, Wilcoxon signed rank test, MATLAB.

1. Introduction

Engineering Education has changed rapidly from the traditional chalk-and-talk approach to one that emphasizes understanding as well as acquisition of knowledge through an increasing involvement in project/problem-based activities[1]. One of the key factors in this paradigm shift is the selection of appropriate assessment method[1]. Assessing educational outcomes is a difficult task because the attributes to be measured are mental representations and processes that are not outwardly visible. An assessment observes students' behavior and produces data that can be used to draw reasonable inferences about what students know. Assessment is deeply rooted in the learning process as it plays a constant role in informing instruction, guiding the student's next steps, and checking progress and achievement. When assessment is properly conceived, designed, and implemented it can serve as a positive influence on attaining the learning goals for students in the 21st century[2]. A well-founded assessment plan should emphasize on three components: a statement of educational goals, which define exactly what is expected of students; a valid set of measures of achievement of these goals as in any good experimental design, multiple measures are best and use of the information gathered to correct and improve

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the educational process[3].The teaching methods and assessment tasks should be aligned with the learning activities expressed by the intended or desired learning outcomes[4].Using an apt assessment method is useful for inducing learning in students especially if it is innovative and engaging.There are several processes and strategies for classroom assessment but teachers should adapt them to suit the assessment purpose. For example, Essay tests let students display their overall understanding of a topic and demonstrate their ability to think critically, organize their thoughts, be creative and original. While, essay and short-answer questions are easier to design than multiple-choice tests, they are more difficult and time-consuming to score. Moreover, essay tests can suffer from unreliable grading[5]. Multiple choice questions can be difficult to write, especially if a teacher wants his/her students to go beyond recall of information, but the exams are easier to grade than an essay or short-answer exams[5]. Multiple choice tests are the most common and perhaps the best tool for objective measurement of knowledge, ability or achievement because of its objectivity, simplicity, and automatic scoring, as well as the possibility of modifying a test based on empirical evidence[6]. Additionally, Multiple choice-based tests create a lower level of anxiety among students in comparison to Essay type test because options on multiple choice tests are made available to students[7-8]. Students can also guess correct option; hence they feel a sense of security and more confidence while taking the test. There is less possibility of being unfairly scored, making spelling mistakes and having poor writing ability is no more hurdle in MCQ based test. Essay exams, however, requires students having additional effort and emotional energy in order to select, organize, and express their ideas in answers. Students generally believe that they can demonstrate their content-knowledge on tests better with test formats that require answer production over answer recognition[9].

Students should have not only multiple opportunities, but also multiple ways to show what they know, and that assessment specifications should include a variety of item and response types that may lead to assessments on which learners are more likely to be able to show their strengths [10]. Assessment and learning are deeply contextualized processes and it is not possible to have a solution that fits every case [11]. Interpretation of assessment data is one of the most

important part of it because decisions based on assessment affect students' learning process as well as teaching style of teacher [11].

2. Hypothesis for the study

A small study was conducted to find out the variation in results when students were examined on the basis of an Essay/short answer type test and Multiple-choice question-based test. The hypothesis(alternate) for the study was taken as - "There is a significant difference between the scores obtained by students in Essay type test and MCQ test."

3. Methodology

Essay/short answer type format of assessment and multiple choice-based question format of assessment were used for two consecutive internal evaluation (Theoretical Continuous Internal Evaluation): TCIE-1 and TCIE-2 of subject Power System Design (Electrical Engineering). TCIE-1 contained 8 questions of 1 mark each out of which students needed to attempt any 6, 7 questions of 2 marks each out of which students needed to attempt any 5, 4 questions of 4 marks each and 1 question of 8 marks. TCIE-2 contained 20 MCQs of 1 mark each and 10 MCQs of 2 marks each. TCIE-2 was conducted online using Google Quiz. No marks were deducted for wrong answers in TCIE-2. Question papers for both the tests were based on Bloom's Taxonomy and were designed by the same course instructor. 90 minutes were given to students for completing the tests and total scores for both the test were same i.e. 40 marks each. These tests were compulsory for student and had 20% weightage separately in semester's final result. One of the limitations of study was that the time lag between both the test was 3 months. However, the syllabus of TCIE-1 and TCIE-2 was not exactly same but the content was correlated and belonged to same subject. The following table shows level of assessment in TCIE-1 and TCIE-2 based on Bloom's Taxonomy-

Table 1. Level of assessment (based on Bloom's Taxonomy)

Knowledge dimension	TCIE-1	TCIE-2
Remember	Tell, List, Enumerate, Recall, What, Name	Tell, Choose, Recall, Find
Understand	Classify, Explain	Infer, Show, Relate, Interpret, Illustrate
Apply	Solve	Solve, Identify, select
Analyze	Examine	Examine
Evaluate	Justify	Choose
Create	-	-

A. Sample questions from TCIE-1 and TCIE-2-

TCIE-1-

Remembering

1. With neat sketch, explain the block diagram of spilt shaft microturbine.
2. Enumerate any two bipolar- HVDC link in India.

Understanding

1. Explain the difference in power flow through AC link and HVDC link?

Apply

1. A bipolar HVDC link is delivering 1000 MW at ± 500 kV, at the receiving-end. Total losses in DC circuit are 60MW. Calculate the following-
 - a. Sending-end power and voltage.
 - b. Voltage and power at middle of the line.
 - c. Total resistance of DC circuit.

Analyzing

1. Discuss the various power quality problems associated with Distributed Generation.

Evaluate

1. Why is reactive power compensation in HVDC transmission line equal to zero? Justify it with mathematical formulae.

TCIE-2

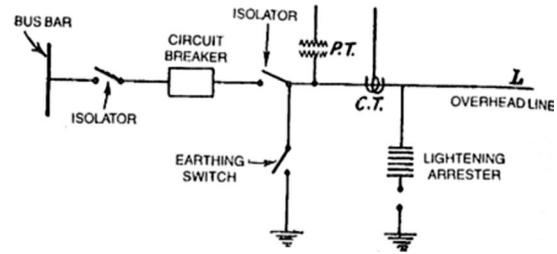
Remember

1. When data of the MD on the primary feeder is not available, then which of the following formula used to compute the voltage regulation.
 - a. $\{(Voltage\ drop\ per\ km.\ kVA) \times (total\ km.kVA)\} / (Diversity\ factor)$
 - b. $\{(Voltage\ drop\ per\ km) \times (total\ km.kVA)\} / (Diversity\ factor)$
 - c. $\{(Voltage\ drop\ per\ km.\ kVA) \times (total\ kVA)\} / (Diversity\ factor)$
 - d. $\{(Voltage\ drop\ per\ km.\ kVA) \times (total\ km)\} / (Diversity\ factor)$

Understanding

1. Which of the following is correct sequence

of operation while opening a circuit, refer the below shown figure?



- a. Open circuit-breaker – close isolator-closed earthing switch.
- b. Open circuit-breaker – open isolator-closed earthing switch.
- c. Open circuit-breaker – open isolator-opened earthing switch.
- d. Close circuit-breaker – open isolator-closed earthing switch.

Applying

1. What will be the value of minimum ground rods, if maximum fault current is 5000A, substation area 47.20m X 31.5m.
 - a. 50
 - b. 10
 - c. 20
 - d. 100

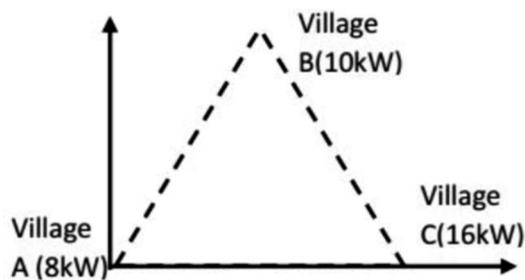
Analyzing

1. It is proposed to transmit 50MW at 0.95 power factor over a distance of 100 km. the line efficiency and regulation should be better than 95% and 10% respectively. Select optimum line voltage of the transmission line.
 - a. 750 kV
 - b. 33 kV
 - c. 22 kV
 - d. 132 kV

Evaluate

1. It is proposed to transmit 50MW at 0.95 power factor over a distance of 100 km. the line efficiency and regulation should be better than 95% and 10% respectively. Select optimum line voltage of the transmission line.

- 308m, 127m.
- 111m, 522m.
- 145m, 156m.
- 856m, 187m.



A. Sample:

The paired sample includes 108 (112 students took exam in TCIE-1 and 108 in TCIE-2 out of 115) students of B.Tech. 8th semester (IV year- Academic session-2017), Electrical Engineering of School of Engineering at RK University, Rajkot.

B. Analysis:

Following graph was plotted to show the difference in marks obtained by same the students in these two assessment methods. Here x-axis represents student number and y-axis represents marks obtained by each individual student.

Following data were obtained from the sample-

Above chart and data represents individual scores of students in Essay/short answer type test and MCQ based test. The graph suggests that most of the students who have obtained higher marks in

Essay/short answer type test have not necessarily scored good marks in MCQ based test although there were few students who scored high or low in

Figure 1: Comparison of scores: Essay/short answer type test v/s MCQ based test

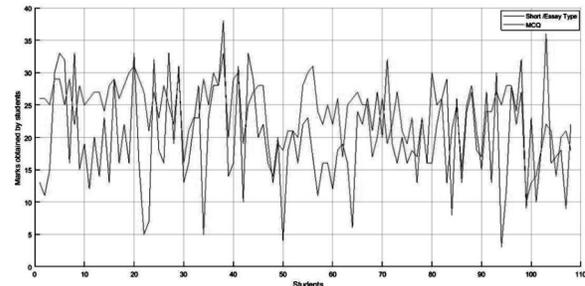


Table 2: Comparison of scores in Essay type test v/s MCQ based test

Parameter	Essay/short answer type test	MCQ based test
Average Score	20	24
Standard Deviation	7.77	4.88

both the tests. This explains that students may perform at different levels in both the assessment methods and it can also be interpreted that both the methods analyze different aspects/skill set of students and therefore, should be used according to nature of learning outcome to be assessed.

5. Testing of Hypothesis:

Wilcoxon signed rank test(Paired) was applied using MATLAB to test the hypothesis. The p-value was calculated as 0.000039128 and $h=1$, so at 5% level of significance the hypothesis of significant difference is accepted which proves that there is a noteworthy difference in scores of students in Essay/short answer type test and MCQ based test.

Furthermore, the correlation coefficient between the two sets of marks is found to be 0.257698 which shows that students' scores in MCQ test and Essay based test are very weakly correlated and the two tests usually assesses students differently.

6. Conclusion

Assessment data play pivotal role in almost every decision of educational institute. The assessment is intended to benefit students by improvement in learning. Assessment should be holistic in nature but also should be tailored to a specific purpose. Assessments should match learning outcomes. It is suggested from the study that students' scores are significantly different in Essay/short answer type test and MCQ based test in most of the cases which shows that these two tests are meant for two different kinds of assessment purpose and should be used accordingly. Essay based tests assess creativity and writing capabilities of students along with an understanding of content. These tests can tap understanding of relationship among knowledge, different patterns of reasoning proficiency, writing proficiency and mastery of the knowledge necessary to create other products. On the other hand, MCQ based tests judge level of accuracy in students together with an understanding of content. MCQ based tests can assess applications of some patterns of reasoning, can assess knowledge prerequisite to skillful performance and ability to create products but examiners cannot rely on this method to tap the skills itself and quality of product. MCQ tests are more reliable if made exhaustive, analytical and reasoning based, easy to administer and are asked in many competition exams after engineering but many a times multiple choice tests are tests of recognition only tapping learners' knowledge of the learning outcomes. Therefore, MCQ tests and Easy type tests should be used in accordance to learning outcomes to be assessed as discussed above.

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