A New Assessment Method in Engineering Education

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Abstract *– Over the last decades, we saw a paradigm shift in the education system from teaching-focused to learning-focused. This could be reckoned as the result of the recognition by the educationists of the diverse learning styles displayed by the learners. In contrast, there were little changes made in the assessment method although assessment is a key activity in the education system. The timed final examination at the end of the study period continues to be the default mode to assess and summatively report the performance of student's learning in many higher institutions of learning. This traditional assessment method is in the author's opinion considered to be an unappropriate assessment method in the modern education system. This issue was looked into and this paper presents some views and a proposed assessment method by the author. Although it does not need to have a pre-determined time for the assessment, but this new assessment method demands much more effort and commitment from the instructors/academics. Also, this new assessment method not only provides a good assessment on the student's learning, but it also enhances deep learning.*

Index Terms – *assessment, action assessment, learning objectives*

Introduction

Assessment is one of the key activities in the education system. In education, we expect a change in the students' capabilities to take place; and there should be clear evidences that such change has occurred. However, how could this change be assessed? How reliable and consistence are the results of the assessment used?

The assessment method currently used in the vast majority of the educational institutions is based on the summative assessment type although some educational institutions have also included some percentages of formative assessment into the system. In the summative assessment, students are asked to sit for an examination/test at the end of their learning period and answer a number of questions in a time frame of one to three hours. Mark or grade will then be given to the students based on their performance in this examination/test. The advantage of this assessment method is that all the students are assessed at the same time using the same questions. The students can be ranked according to their "ability". It is thought that this is the only way to assess whether the student has learned what they are supposed to learn. The question is does this assessment method reflect the true picture of the students' learning or the change that has occurred to the students' capabilities? A quotation from a Psychology undergraduate gives some insight to this issue: 'I hate to say it, but what you have got to do is to have a list of 'facts', you write down the important points and memorize those, then you'll do all right in the test…If you can give a bit of factual information – so and so did that, and concluded that – for two sides of writing, then you'll get a good mark'[1].

Over the last three decades, much efforts have been put in by researchers and educationists, and resources poured in by the educational agencies and authorities to find ways and means to improve and/or enhance students' learning. Characteristics and behaviours of students during their learning have been researched, learning models and students' learning styles have been established [2]-[5], teaching techniques or approaches have been reviewed [6]-[12], new technologies such as multimedia facilities have been incorporated and employed in teaching [13]-[16]. Undoubtedly, we have witnessed a lot of changes taking place in teaching and learning in higher educational institutions. The focus of higher education on students' learning has constituted to a paradigm shift in educational philosophy and practice, from teaching-centred to learning centred.

The educationists have recognized that student's learning is to a large extent affected by assessment methods [17][18]. However, despite the drastic change that have taken place in teaching and learning, there was little progress in the area of assessment. As Joanna Bull [19] mentioned, 'Assessment is still, not only the afterthought of higher education, but also steeped in tradition and culture'. Efforts have been made to align assessment with learning outcomes or learning objectives [20]-[22]. Attempts have been made by Alverno College, King's College, California State University and Western Washington University, as reported by Richard Frye [23], to change the assessment procedures to meet the learning objectives and outcomes. Educationists have also began to realize the problems and the mismatch of currently practiced summative assessment with the demand of today's students and society. These problems are well iterated by Peter Knight [24] on the disarray of summative assessment. Other serious problems that I would like to highlight here include ease of plagiarism in summative assessment [25] [26] and the inherent disadvantage that it results in surface learning; Biggs stated that 'students learn what they think they will be tested on. … this will result in inappropriate surface learning' [17]. Any

assessment method or procedure that is used cannot be considered as effective and reliable if it does not relate to learning that has taken place. If the assessment method is based on reproduction of previously learned content or some known set of examination forms, the students are most likely to adopt the surface learning style [2d]. In this case, the student will not benefit from the learning process and is unlikely to make much useful contribution to the social and/or economic development of the humankind.

In this paper, the author first discussed briefly on the purpose of assessment and then proposed a new assessment method, in the light of the new environment that we are in. The author proposed a number of elements for assessment and the assessment method itself and finally discussed some of the advantages with this new assessment method.

Purpose of Assessment

We might like first to ask ourselves: what is the purpose of having the assessment? Is the assessment meant to grade and rank a student? Is the assessment meant to provide a license for him/her to practice as an engineer? Is the assessment meant to help the students in their studies? Is the assessment meant to provide feedback to teachers to improve the teaching or the curriculum designers to regulate the curriculum? Is the assessment meant to…..

Mutch and Brown [27] divided reasons for assessments into three key areas: (a) student learning, (b) certification, and (c) quality assurance.

Student Learning	Certification	Quality Assurance
To provide feedback to improve student learning	To pass/fail a student	To provide feedback to lecturers
To motivate students	To grade/rank	To improve teaching
To diagnose students strengths, weaknesses	To license to proceed/practice	To monitor standards over time

It can be seen from this classification that the traditional summative assessment only served certification area and partially served the quality assurance area -- mainly for monitoring standards over time, but not on the student learning area, which is now becoming the main focus of educational institutions. In view of the shift from teaching-centered to learning-centered educational philosophy and practice, assessment can only be effective and meaningful if it relates to learning that has taken place. The ultimate purpose of assessment should not be to rank or grade a student, not to mention failing a student. The student enrolled in a discipline to learn the "trade" of the discipline, not to ask for a ranking. In my opinion, the purpose of assessment may just well be divided into two key areas, viz., (i) student learning, and (ii) quality assurance. Assessment should be treated as an integral part of learning.

Elements for Assessment

Before engaging in the discussion of the new assessment method, it is necessary first to identify the elements for assessment with reference to the changed environment that we are now in.

Today, the curriculum of a university engineering program typically consists of five major components, namely, lectures, tutorials, laboratory experiments, projects and industrial training. Under these curricula, theories and concepts were delivered largely through lectures in a sequential manner. This is good for those, following Felder-Silverman's model [3], intuitive, deductive and sequential learners. Also, the curricula provided opportunity for active participation from the students through tutorials, laboratory experiments, projects and industrial training. This is a great advantage to those active and sensing learners. The curriculum has indeed been well designed, with respect to Kolb's learning model [2], in that it takes into consideration the diverse learning styles of the wide variety of students in a class. It should be recognized that the whole purpose of all these activities of learning is to ensure that these varied students are able to learn the intended knowledge or skills and be able to apply them to solve everyday problems. In other words, although the basic theories and concepts are essential, but they need not be the items for assessment. What really important is the ability to apply these basic theories and concepts to solve problems at hand. After all, the basic theories and concepts can be referred to (with the relevant resources) whenever needed to. So, the first element for assessments is the ability of the student to apply the fundamental knowledge or skills they have acquired to solve problems at hand. On the other hands, ability to apply learned knowledge will very often involve, when extended, analysis and synthesis skills. When assessing students' ability to apply learned knowledge, these skills should also be taken into consideration.

One common encounter in a teacher's teaching experience is the following. It had happened that when some third year Engineering students were asked to measure the current of a branch of a transistor circuit in the situation that no part around that branch could be broken to insert an ammeter, some of them were lost, did not know what to do. Some students even set

the multimeter to milliampere range (which is correct) and put the multimeter probes across (which is not correct) the resistor to measure current through that resistor. Ohm's Law was learned in the school, applied in the network analysis in first and second year of tertiary education; but it was "forgotten" when given a real life problem. When asked to trouble-shoot the problem(s) when a transistor circuit was not working or not functioning properly – many students were lost, did not know what to do, or where to start. So, how reliable is the result that the student has obtained good performances in the previous final examinations? A student may have obtained good results in his/her examination, but he/she is really not as skillful or knowledgeable as what the teacher or the curriculum wanted him/her to be. So, another element to be included for assessment is the consistency of the student's ability to apply knowledge and skills acquired.

The recent advancement in computer technology and the introduction of internet have brought the development of humankind a step further into the technological and information age, where information is "everywhere" and "easily" accessible. For instance, in the past, when one requires to get some information of a say transistor or integrated circuit (IC) regulator, one has to look for the manufacturers or their distributors for the data-sheet. This often takes time and information may not come in complete format. Also, it may be difficult to keep up with new information or new product from a particular company or manufacturer even if, at one point of time, one managed to get a databook from the company/manufacturer. This information is now readily available with a click of few buttons on your computer keyboard -- through the internet. Besides, modern educational institutions are now sufficiently equipped with computers or internet facilities so that students can access the internet anytime for the information that they required. However, this can also post some problems if one does not know what information to look for. So, in this new environment, the skill or ability to seek and to sift information are becoming increasingly important. This should also be considered as an element for assessment.

Another element for assessment is the ability to integrate various knowledge or skill learned or acquired at different points of time or at different stages of the learning period. For instance, one learns about the behaviour or characteristics of a capacitor during charging or discharging at one stage or point of time. At another stage, one learns about the characteristics of a diode that it rectifies a signal. At another stage, one learns about the behaviour of a transistor. Now, if one is able to integrate all these three knowledge, one will not find any difficulty in understanding, analyzing or even designing a pulse generating circuit based on transistors (and capacitor). Otherwise, it will take one a long time to understand how this circuit works, not to mention designing it.

When a student finally graduated and started working as an Engineer, he/she will have to work with many other people. He/she needs to work not only with other engineers, but also with non-engineers such as financial personnels , administration personnels, etc. as well as technicians and clerks, of different age groups. So, ability to communicate, verbally or in writing, with others is an essential skill that will help him to navigate successfully in his/her working environment. Moreover, engineers are expected to report and convey very precise and concise messages to the managers or peers. So, oral communication skill, good report writing skill, presentation skill and teamwork should be included as elements for assessment.

Another important element of assessment is initiative. This element is important not only when the student goes out to work one day, but also during the learning period. If there is no initiative in the student himself or herself, it is almost impossible for the student to learn anything or do any good job; no matter how good his/her teachers or supervisors are and how best the facilities for his/her learning or work area have.

Last but not least, the safety consciousness in a work place is a very important quality that, in particular, the engineer should have. Ignorance on this factor could cost a fortune. The engineer should always be alert on any sign of danger or potential danger that is around him/her and know how to handle and prevent accidents from happening. An extension of this is of course that the engineers should always bear in mind that safety is something that should be designed into the products.

Assessment Method

The elements for assessment proposed above are indeed qualities that cannot be measured just at one point in time, or by setting a question and asking the students to answer it during a specified duration. It is the qualities that need to be developed over a period of time. It is the qualities that could only be confirmed over an observation period. These elements for assessment entail skills or capabilities beyond the six cognitive skills of Bloom [28], viz., knowledge, comprehension, application, analysis, synthesis and evaluation.

To ensure the above qualities have been developed in the students in the framework of the curriculum that is drawn up by the universities or the higher educational institutions, it is necessary that a continuous record of the performance of the students be made available. Both the students and the teachers should keep journals or diaries where both parties meet regularly to discuss the progress of the students in their learning. The meeting could be a teacher meeting a student or a teacher meeting several students as a group or even a few teachers meeting a group of students, or a few teachers meeting a student. What is important here is after the meeting and discussion, a record is made on the achievements made by the

students and the areas that the students need improvement. These conclusions should be agreed and signed on the journals or diaries by both the teachers and the student. The meeting and discussion is a means to assess the students in their learning and to provide immediate feedback to the students on their learning. The records served as evidences that the student is progressing and whether the students have achieved all the elements for assessment as discussed in the previous section over the learning period, for example, over the four years engineering program.

It is worth at this juncture to emphasize that the so called assessment method here is actually being made an integral part of students' learning. It differs from the commonly practiced assessment methods in the sense that this is a continuous process and it takes place anytime convenience to both the teacher and the student. The teacher knows the progress of the students and simultaneously the students get the feedback on their studies immediately. The next assessment could be the next day, if both the teacher and student are willing to do so. In view of the nature of this assessment activity, the author will like to call this assessment method as Action Assesssment.

Some of the advantages of Action Assessment are as follow.

(1) It caters to the different learning styles of the students, and to the different rates of learning by individual students. This form of "assessment" is student-centred. There is no forcing on the students to follow the speed and the way the teacher teach, there is no forcing on the students that they must finish the topic syllabus within the specified time. The students learn through a style that best fit them and that they could fully exploit to their advantage. For the slow learners, there is no need for them to rush through (hence without understanding the subject matter). At the same time, the progress of the fast learners in their learning is not hinder by the slower learners in the class.

(2) It promotes deep learning. One needs to have a good understanding of the subject matter before one is able to apply it to different settings or situations, that is, the problems at hand. To achieve this, the students need to make sure they understand the subject matter properly. There is no chance of surface learning. As stressed in the previous section, the basic concepts and theories are essential but not "examinable". The assessment will not be based on how many of these concepts or theories they have learned or know – eventually they need to learn all.

(3) It eliminates plagiarism, which is an increasingly talk about issue in the education arena. This form of assessment does not require the students to sit for examinations and hence memorizing lecture materials or pre-prepared solutions to spotted questions from questions bank or pass year questions have no role to play here. Also, the level of understanding of a course content and the way the knowledge are integrated in students vary from one to another in accordance with their past experiences. The settings during the discussions between the student and the teacher would be different in each case.

(4) It ensures full and quality education is given to the students. At the end of the learning period, the students are not only well-versed in the engineering technical matters or contents, but also able to apply what they have learnt to problem solving, a more caring person, be always willing and ready to make positive and useful contributions to the society, etc.

Conclusions.

In view of the new environment of information and technological age, and learning-centred educational philosophy and practices we are in today, it is strongly recommended to review the assessment methods used in educational institutions. A new assessment method called by the author as Action Assessment is proposed here where the students will be "continuously assessed" over the span of the engineering program that they have engaged in. It is also proposed to include the following as the elements for the Action Assessment.

a) Ability to apply acquired knowledge/skills.
b) Consistency of the ability to apply acquired knowledge/skills.
c) Ability to seek and sift information.
d) Ability to integrate various acquired knowledge/skills.
e) Oral communication skill.
f) Good report writing skill.
g) Good presentation skill.
h) Teamwork.
i) Initiative.

In this new assessment method, the understanding of basic concepts and theories are viewed as essential and need not be included in the assessment. The assessment is viewed as a means to provide immediate feedback to the students and to help students in their learning. The advantages with this proposed "assessment method" include promoting deep learning, eliminating plagiarism and ensuring quality education.

Further research and studies into this new concept of assessment is very much recommended.

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