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As Engineering Teachers, Do We Resemble A T20 Cricket Batsman or A Test Cricket Batsman?: Let Us Introspect

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Abstract - *The title might puzzle the readers. The author positively hopes that the work carried out and the content presented in this paper with reference to an effective teaching-learning process, in general and teaching-learning mechanism in engineering education, in particular would probably convince the readers about the appropriateness and relevance of this unusual sounding title. The so called smart engineering students of Generation Z are habituated to shortcut and mechanical way of learning rather than in-depth and conceptual learning; so, they tend to pursue the teacher for a quick way of teaching. Hence, the attainment of various learning levels, as depicted in Bloom's taxonomy, in a true sense, remains an ambiguous issue. The author shared his short video with the second year civil engineering students to carry out an interesting exercise through Google form survey. The video contained a demonstration of calculation of two support reactions of a simply supported beam, from first year engineering mechanics course. Intentionally, the problem was demonstrated in a highly mechanical way through the video, without explaining the concepts at depth. A Google form containing 8 questions was circulated among the students. In all, 46 students responded. The first question was exactly similar to the problem demonstrated in the video. It was correctly answered by 30 students, thereby making the passing rate as 65.2%. Questions 2 to 8 were related to the first question; however, critical thinking and conceptual teaching was needed to answer those. Most of the students performed poorly while attempting those questions. This clearly underlined a dire need of imparting strong fundamentals to the learners by an engineering teacher. Along with discussing the significance of various modern tools and techniques for an efficient teaching-learning mechanism, this paper mainly stresses upon the need of conceptual teaching.*

***Key Words*: Bloom's taxonomy, teaching-learning, conceptual teaching, modern tools and techniques of teaching, e-learning, Google form survey, etc.**

1. INTRODUCTION

Engineering is all about applying science and technology to design, create and upkeep the structures, machineries, various advanced devices, etc. [1]. It facilitates engineering graduates to have a successful professional career, take part in lifelong learning and play an important role for the societal development. At graduate level, it is expected that the learners will be self-motivated and disciplined; they will make use of already acquired cognitive skills to understand the concepts taught by the teachers. However, engineering teacher has still a crucial role to perform in order to create an effective framework which motivates students to grasp the concepts most efficiently. Clark [2] gave an equation to represent the main ingredients in higher education teaching, which bring about the improvement of performance of students. Below is the equation [2, 3]:

[Relationships + Variety + Synergy] = Environment for success

The effective learning by students and their academic achievements are governed by the instructional qualities of a teacher [4]. The process of teaching is complicated and great practice takes time, excellent teaching material, passion for the profession and tailored feedback meant for the continual improvement and growth of a teacher [5]. Excellence in teaching does not happen by chance. It's not a miracle. Owing to the enormous stress on enhancing higher education quality, effective teaching is becoming imperative day by day.

Fig.- 1: Requirements of Good Teaching [6]

Parameters that affect the good teaching are learner, teacher, objectives and content [7]. The useful parameters to attain excellent teaching practices are organization of lesson, clarity of lesson, positive classroom atmosphere and interest in learning [8]. Some good teachers may be born, but most of them are made [9]. Good teaching has a mixture of different attributes like thorough knowledge about content, pedagogical skills, capability to inculcate same concept in a number of ways, motivating the students, strong commitment towards students and parents, capability to

manage and assess the students from the diverse background.

Most of the teachers inculcating the engineering courses find shortage of time to cover the voluminous syllabus in short semester duration. Moreover, to cater to the shortcut learning style of so called "Gen. Z" students, they resort to "HOW" type of teaching rather than "WHY" type of teaching. They don't explain "why" a certain step is to be carried out and various approaches for the same; rather, they try to convey "how" to do it mechanically to obtain the answer.

2. COGNITIVE DOMAIN OF LEARNING

This domain comprises of learning skills in connection with the process of thinking. Learning mechanism in this domain consists of a hierarchy of skills involving information processing, building up the understanding, knowledge application, problem solving and carrying out the research. There exist six tiers of cognitive complexity: knowledge, comprehension, application, analysis, synthesis and evaluation.

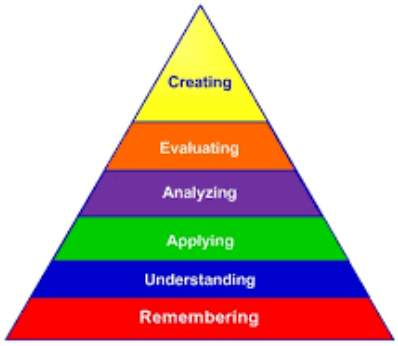

Fig. – 2: Revised Bloom's Taxonomy [10]

The focus of Bloom's taxonomy was mainly on the attainments of various learning levels. It did not mention the process skills. It also failed to cater significantly to address the way in which a student jumps from lower level to higher levels. This domain consists of skill clusters that help to organize a complete, precise and complementary listing of learning skills which are crucial for each process. There are various added features in the modified version of Bloom's taxonomy [10]. Presumably more complicated mental operation is needed for attaining the higher learning levels. If students lack capability of making use of lower levels, they cannot attain the higher levels. Therefore, it's not necessary that the higher levels are greatly desired than the lower levels.

3. MODERN TOOLS AND TECHNIQUES OF TEACHING WILL REPLACE TRADITIONAL TEACHING: REALLY?

Various modern teaching techniques which have already proven their worth in enhancing the student's learning process are flipped classroom, tactile learning, VAK learning, project-based learning, problem-based learning, cooperative-learning, collaborative-learning, game-based learning, inquiry-based learning, thinking-based learning, competency-based learning, independent-learning, etc. Off the late, there is much talk about usefulness of Massive Open Online Courses (MOOCs). They create interactive user forums which facilitate in building a community comprising of teachers, learners and teaching assistants by providing course material videos, hand-outs, problem sets, etc. There are many digital tools and apps for the teachers. Quizizz, Teach Easy, Jamboard, Mentimeter are the few to name. During and after Covid pandemic, the use of digital mode of teaching-learning like Google class room, posting YouTube videos, Google Meet, Zoom, Microsoft Team, Go To Meeting, etc. have been on the rise. Some students find traditional teaching stressful and modern tools and methods joyful for their learning. Modern learning mode motivates the learners to collaborate with each other. Online learning model facilitates the students with online platform for discussions. Through e-learning, students have an advantage of learning with their own pace. However, a traditional teaching provides face-to-face working for the students. It is more direct. Interpersonal skills are developed among the students. Blended learning which combines traditional and modern techniques of teaching is also a better option to save on time and to improve learners' academic performance.

The utilization of modern teaching tools and methods does not necessarily ensure that the concepts are taught correctly and at real depth. These are completely two different things. Many engineering courses, highly analytical in nature, demand in-depth and conceptual teaching. It is usually said that "state-of-the-art infrastructure and aesthetically pleasing buildings alone don't make the institute; but, the motivated human resources and passionate students make the one". On the similar line, only making use of smart modes of inculcating the students without bothering about the importance of instilling the fundamental concepts in them is like accelerating a car without changing the gear. It will only make a noise without gaining the speed. Traditional way of teaching has its own peculiarity and significance. Hence, it cannot be fully replaced by the modern and smart methods. It can only be substantiated through novel approaches using technological advancements.

4. OUTCOMES OF GOOGLE FORM EXERCISE AND DISCUSSION

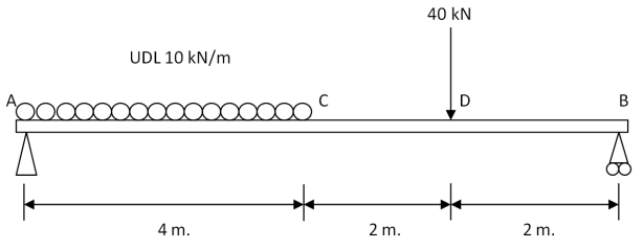

Fig. – 3: A Simply Supported Beam

After students watched author's short video, they were given a similar problem (figure 3), through the Google form and 8 questions were asked. Responses of 46 students are indicated below.

Q. (1) Calculate the reactions at hinge support A and roller support B and choose the correct option.

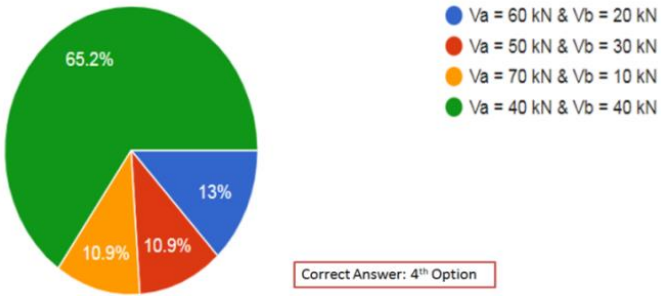

Fig.- 4: Calculation of Support Reactions

The correct answer was fourth option. It was correctly answered by 30 students, thereby making passing percentage as 65.2%. It was expected that everyone would answer correctly because it required only mechanical way of solving without critical thinking process involved. However, students' performance was just satisfactory.

Q. (2) If roller supports are provided at both the ends of the beam, the beam will be stable. True or False?

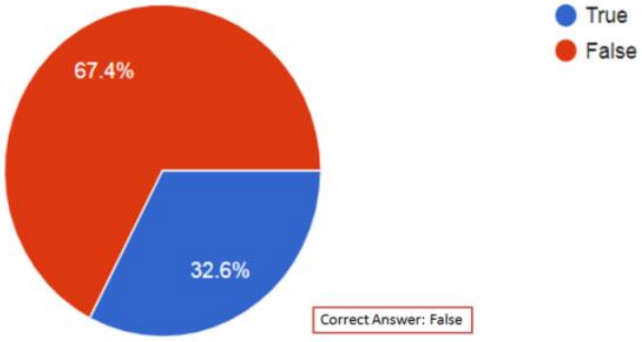

Fig. – 5: Knowledge about Beam Stability

The correct answer was "False". Question 2 required a bit of conceptual thinking. 31 (i. e. 67.4%) students could answer it correctly.

Q. (3) Clockwise action for moments and upward direction for loads and reactions were assumed positive in the video demonstration. If anticlockwise moments and downward loads and reactions are assumed positive, magnitudes and directions of reactions at A & B will remain unchanged. True or False?

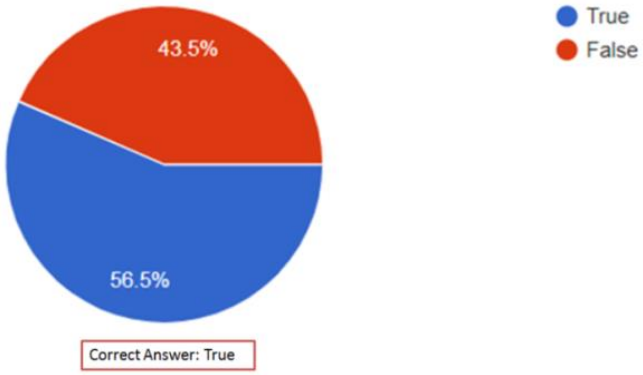

Fig. - 6: Concept of Sign Conventions

The correct answer was "True". It was answered correctly by only 26 (56.5%) students. This proved that the students' concept about sign convention was not clear. This concept is vital to learn higher semester courses.

Q. (4) After solving any such problem, if we get total upward forces (i.e. reactions) equal to total downward forces (i. e. loads) as a final cross check, does it definitely ensure that values of both the reactions are correct? Select Yes or No.

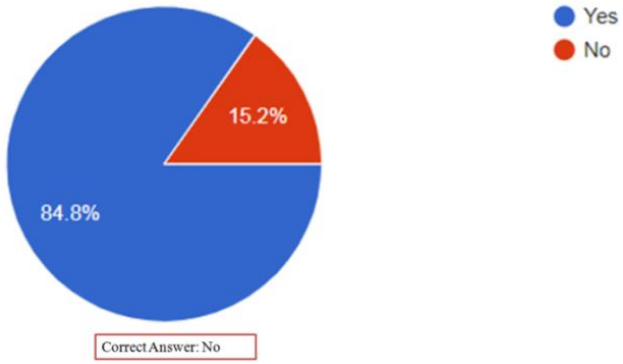

Fig.-7: Knowledge about Cross Checking the Answers

The correct answer was "No". Only 7 (i.e.15.2%) students could correctly answer question 4. It was related to the final cross checking of the correctness of two support reactions. This is a serious concern owing to the trial and error style of students' learning.

Q. (5) Initially, instead of assuming both reactions to be acting upwards, if both are assumed acting downwards or any one acting upwards and any one downwards, will there be any changes in values (magnitude or direction or both) of reactions at supports? Select Yes or No.

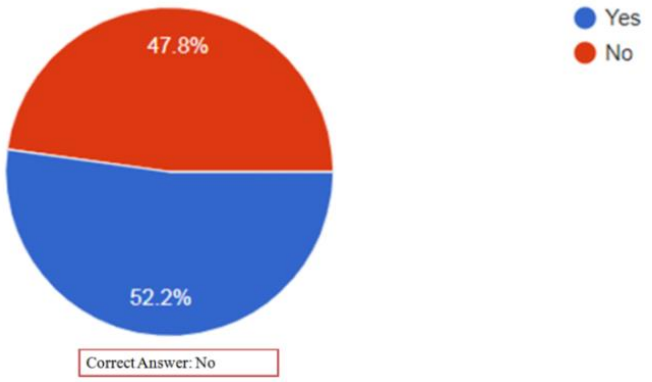

Fig. - 8: Initial Assumptions of Directions of Reactions

"No" was the expected answer. Students did not fare well in question 5. The desired answer was given by 22 (i. e. 47.8%) students only.

Q. (6) If your answer was any of the first 3 options in question (1), neglect this 6th question. However, if your answer was 4th option (i.e. both the reactions are same) then shortly write your comment: why both the reactions are same?

The expected answer was: The external effect of given uniformly distributed load is equivalent to a point load of 40 kN acting at 2 m. from the end A. So, it becomes a symmetrical loading case. Out of 46 students, only 6 students could write approximately close answer. But, none of the answers was precise. When precise descriptive answer involving a technical concept is sought in engineering, answers reflecting a grey area cannot be accepted.

Q. (7) To ensure less chances of making mistake, is it better to use $\Sigma M_A = 0$ or $\Sigma M_B = 0$?

The desired answer was $\Sigma M_A = 0$, because Uniformly Distributed Load is closer to A. Out of 46 students, only 15 (i. e. 32.61%) students wrote the correct answer.

Q. (8) Conceptually, at how many points on the beam ACDB, $\Sigma M = 0$ can be written?

The expected answer was: At every point on the beam. However, no student answered it correctly, thereby indicating that though they learnt equilibrium equations to solve the problems, they were unaware of the precise underlying concept. Questions 2 to 8 were related to the first question. However, unlike the first question which demanded only mechanical approach, those questions demanded conceptual and lateral thinking skills.

One more interesting analysis was done and it was found that, out of 30 students who obtained correct reaction values in first question, only 21 (i. e. 70%) students answered second question correctly, 15 (i. e. 50%) students attempted third question correctly, only 3 (i. e. 10%) students could answer fourth question correctly, 15 (i. e. 50%) students answered fifth question correctly, no one answered sixth question correctly, 14 (46.67%) students attempted seventh question correctly and no one was successful in answering the eighth question correctly.

As a part of maintaining the academic documents for the assigned subject, engineering teachers mention that the topic learning outcomes and various course outcomes have been successfully attained at the required Bloom's learning levels through the activities like assignments, term tests, viva-voce, end semester examination, etc. However, attainment in a real sense is a big issue.

Had the in-depth and conceptual teaching been demonstrated through the author's video, most of the students could have probably answered all the questions correctly.

5. SUMMARY AND CONCLUSIONS

The hierarchy of skills as well as processes in cognitive domain need to be thoroughly understood by teachers and students so that they are able to know prerequisite knowledge for learning and also the manner in which the skills are required to be transferred to achieve excellence in complex elements of discipline-specific concept inventories. For teaching or learning new concepts, development of learning skills shall never be taken for granted. Imparting conceptual knowledge to the engineering students is the only way for a complete teaching-learning mechanism. Though the major objectives of engineering education are success in examination and good placements, they cannot be the only driving forces. Passing the examination does not necessarily ensure that the students have acquired knowledge through the fundamental and in-depth learning. The ultimate aim of engineering teacher is to create a positive environment for students to be a better engineer possessing sound domain knowledge. If the trees are cut (after their useful life is over!!!!!) with a blunt axe, to save upon sharpening time, it leads to more effort with low efficiency. On the contrary, if enough time is given to sharpen the axe initially, time and efforts can be saved later on. Engineering teachers facing the shortage of time are unwillingly compelled to finish-off the content in a mechanical way to get aligned with the students' quick learning styles. However, they can invest an extra time and plan meticulously so that their teaching becomes an optimal combination of conceptual inputs and mechanical approach.

This is a very crucial factor in engineering education because success cannot be measured only quantitatively in terms of students' passing percentage, placements, etc. It has to be also assessed in the light of qualitative approach such as students qualifying GATE, cracking various Government examinations, enrolling for higher studies and research programs in premier institutes, etc. Conceptual teaching is like a complete meal and usage of modern tools and methods is like a pickle. The later spices-up the former, thereby making the meal interesting. But, a meal having different quality ingredients cannot be completely replaced by a pickle or a combination of different types of pickles!!!

If engineering students are taught only from the examination point of view, they may pass or even score well. But that is not the sole purpose of obtaining an engineering degree. They need practical and lateral thinking approach to survive and thrive in the real world.

The unorthodox and bad shot hit by a batsman in T20 cricket match fetches a boundary for the team, owing to the kind of field set up. It takes the batsman and team towards the success in terms of winning the match. The spectators in the ground and those watching the television get an ephemeral joy. However, when the same batsman plays a test cricket wherein the field set up is entirely different; combined with an in-depth analysis for every ball being bowled, he gets caught without any significant contribution to his own score and the team score. In spite of having excellent batting skills, he miserably fails because of his habit of shortcut way of attaining the objective of winning to satisfy the team requirement and to cope up with the whims and fancies of spectators. Instead of explaining how this analogy is related to the engineering teacher, his/her department, college and students, the author leaves it to the imagination of readers to read between the lines and understand a vital message in disguise to bring-in the much needed changes in teaching-learning process in engineering education.

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