

A CASE STUDY ON QUALITY OF SETTING UP ENGINEERING QUESTION PAPERS

GANESH KUMAR. N¹, MOHANRAM. P. V² & RUDRAMOORTHY. R³

¹ Assistant Professor, Department of Mechanical Engineering, PSG College of Technology, Coimbatore, Tamilnadu, India

² Professor & Head, Department of Mechanical Engineering, PSG College of Technology, Coimbatore, Tamilnadu, India

³ Principal, PSG College of Technology, Coimbatore, Tamilnadu, India

ABSTRACT

Engineering discipline is a prominent and promising field for decades for the students to select as a career path. In addition, this discipline provides a wide range of engineering career opportunities, better salary, and well respected in society. Therefore, it is imperative for engineering institutions to provide quality engineering education to their customers (students). In order to improve the student creativity, it is important to teach them using active and student centric learning methodology. One such methodology is the usage of Bloom's taxonomy approach in setting up question papers. In this paper, a comparative case study of question papers set by faculty in two prominent institutions (one in India and the other in USA) was conducted, where several question papers were compared as per revised Bloom's taxonomy. It was interesting to note that (a) both the institutions were setting up the question papers similarly in low order thinking skills; (b) The institution in India has a slight edge over the institution in USA in application and analysis domains; (c) The institution in USA has a high edge over the institution in India in high order thinking skills. In addition, this paper demonstrated where, what and why a student would lack in achieving category (c). Several recommendations for improvement in new teaching methodology are also discussed in this paper.

KEYWORDS: Engineering Question Paper, Bloom's Taxonomy Approach, Active and Student Centric Learning; Engineering Educational Institute

INTRODUCTION

In this global competitive world, it is imperative that the engineering institutions should provide quality education to their customers (students). Failure to provide a reasonable or good quality education would lead to low enrolment of students in their institution. It would even lead to shutdown of an institution, in the worst scenario. As an educationist, it is important that the engineering institution should provide quality education to the students because they are the key promoters in building a prosperous nation. The knowledge, research and skills of a student would give a competitive advantage to a country [7]. In addition, companies are in-demand of talented students with ethical leadership quality. According to ladders.com [13], there is 70-80% of vacancy, each year in top management positions because it is difficult to find the right talented people with the leadership quality.

In general, in India, as a part of the culture, parents have upper hand in making decisions in selecting his or her child's higher education choice. Majority of the parents opt their selection to either engineering or medicine as their first choice. The reasons to select the engineering are: (a) it provides a wide range of disciplines to choose from, such as mechanical, production, aeronautical, electrical and electronics, computer science, information technology, civil, textile, agricultural, to name a few; (b) it offers a promising career with decent salary; (c) well respected in the society; and (d) able to select better life partner. Having said that, once an engineering student graduates from an institution, he or she has several options to select in his or her life. Figure 1 depicts some of those available options for a student.

A successful engineering institution always aims at making a student fall in the first three categories of Figure 1. The first category (able to get job) indicates that the engineering institution knows exactly what the industry expects. For this, the colleges would do whatever it takes to make their students well equipped to meet the industry expectations. Similarly, to achieve the second category (entrepreneurship), the colleges would set up their syllabi to satisfy that need. Some institutions would provide additional courses to their students to enhance the entrepreneurial, technical, and soft skills [13]. In simple terms, the institution would provide the necessary tools and support for the students to become entrepreneurs. The third category is pursuing higher education, which would be usually the student's choice. The institution reputation across the global, peer pressure among students and student quest for knowledge could lead to this choice.

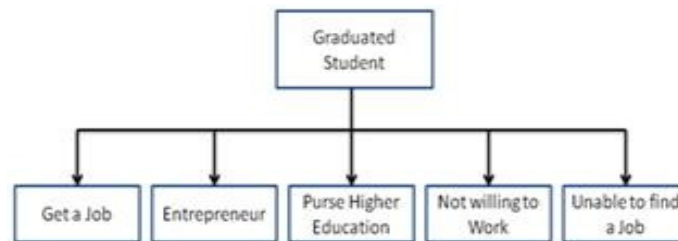


Figure 1: Student's Outcome after Graduation

When an engineering institution is able to produce high percentage of students in first three categories of Figure 1 and has the ingredients of Figure 2, then that institution will be well recognized in the society, parent's mind, research institutions, industries, etc. The salient aspects of quality engineering education framework [13] is provided in Figure 2. This also gives a motto for the parents to select that engineering institution as their first choice for their children. This data also aids the industries to select the students from this institution. Achieving these targets, is a great challenge and it takes tremendous amount of time and effort by well trained, competent faculty and visionary top management.

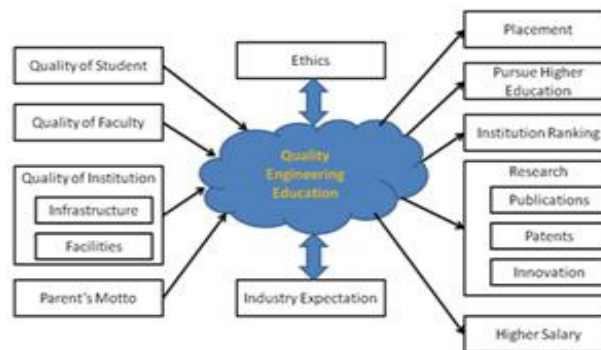


Figure 2: Quality Engineering Education Framework
[Source: G. Patel et. al, 2004]

The well trained competent faculty always look for new challenges and ideas in teaching methodology. Bloom's taxonomy is one such tool, which has aided several institutions to achieve the above targets quickly and easily. The Bloom's taxonomy approach is to provide a clarity to educational objectives by helping faculty prepare better-designed courses, achieve more student centred learning and outcome oriented evaluation criteria. Using this approach, a faculty could setup their question paper so that their students could excel in their studies and able to achieve first three categories of Figure 1. This paper covers how this approach was adopted in their institution. A comparative case study on question papers setting among top 20 best institutions in India and USA was conducted to analyze the quality of question papers. A gap analysis results are also discussed in this paper.

BACKGROUND

According to Indian Census 2011, there are 1.21 billion people live in India. This makes India as the second largest country in the world in terms of population, next to China (1.34 billion people). In India, there are 64.8% of the population are literate [1]. As of 2009 statistics, there are 592 registered Universities [15] and 45,000 colleges in India [4]. In India, approximately 3,50,000 engineering students [2] out of 20,00,000 students graduate each year [14].

To develop a quality educational institution, there are several factors to consider. Table 1 illustrate some of those factors involved. In addition, a quality institution also looks for new teaching methodologies to compete. To improve student's IQ, there are several techniques. One such technique is setting up the question paper in such a way that the student could use his or her creativity and answer the questions straight to the point (precise and accurate) and also demonstrate well advanced thinking. For this, understanding of human brain pathology may help.

Table 1: Factors to be considered in Developing a Quality Engineering Institution

Factors	Outcomes
1) Teacher-student ratio	1:05:00 AM Effective teaching 1:15:00 AM Economical reason
2) Quality of faculty	(a)Method of teaching (active learning and student centric learning); (b) Teaching experience; (c) Industry experience; (d) Educational background; (e) Industry link; (f) Research activities; and (g) Ability to link industry requirements in teaching
3) Quality of student	(a)Student motive; (b) Interest; (c) Opportunities; and (d) Family background
4) Quality of parents	(a)Parent motive; (b) Interest; (c) Peer pressure; and (d) Family background
5) Institution	(a)Admission process; (b) Reputation; (c) Facility; (d) Infrastructure; (e) Adaptability; and (f) Industry link
6) Government	(a)Approval process; (b) Policy; and (c) Funding

According to the human brain dominance theory, the right side of the brain is best at expressive and creative tasks. Some of the abilities that are popularly associated with the right side of the brain include: recognizing faces, expressing emotions, music, reading emotions, color, images, intuition, creativity, to name a few. However, the left-side of the brain is considered to be adept at tasks that involve logic, language and analytical thinking. The left-brain is often described as being better at: language, logic, critical thinking, numbers, and reasoning, to name a few [6].

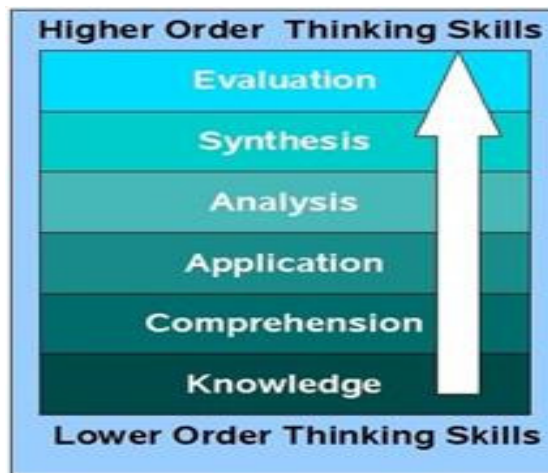
To develop creativity skills, it is important that a person should know when, where and how to use left side of the brain and right side of the brain. Sometimes, for a given problem, use of both left and right sides of the brain may be important. For higher order thinking skills (refer Figure 4), use of both side of the brain is mandatory. The educational institutions should develop a teaching methodology in such a way that their students would use both side of the brains. One such simple technique is to set up the test/examination question paper as per revised Bloom's taxonomy approach.

Bloom's Taxonomy

One of objectives of a successful educational institution could be to make their teaching methodology be active and student centric and expect the student to put in effort into learning. Bloom's taxonomy provides a well-accepted pedagogical framework for classifying vast numbers of educational objectives into useful structures [16]. Table 2 illustrates the original Bloom's taxonomy of educational objectives and Figure 3 illustrates the same but expressed in terms of thinking skills.

Table 2: Original Bloom's Taxonomy of Education Objectives

Domain	Description
Knowledge	Aids in recalling previous learned information.
Comprehension	Comprehends the meaning, translation, interpolation, interpretation of instructions, problems and extrapolation.
Application	Concepts in the use of abstraction in particular and in concrete situations. Here, what was learned in the classroom would be applied into novel situations in the workplace.
Analysis	In-depth analysis and distinguishes between facts and inferences.
Synthesis	Ideas in the production of unique communications and plans.
Evaluation	Leading to judgements about the value of ideas, materials and methods for given purposes.

**Figure 3: Original Bloom's Taxonomy in Terms of Thinking Skills**

Later, Lorin Anderson, a former student of Bloom, revisited the cognitive domain in the learning taxonomy in the mid-nineties and made some changes, which lead to the discovery of revised Bloom's taxonomy [9]. Figures 4 and 5 illustrate the revised Bloom's taxonomy. In this, Donald Clark [8] explained the revised Bloom's taxonomy as only the last two domains are interchanged. In evaluation domain, make judgments about the value of ideas or materials. Finally, create or synthesis domain builds a structure or pattern from diverse elements. In this domain, put all the parts together to form a whole, with emphasis on creating a new meaning or structure. For this, use of both side of the human brain is required.

According to Anderson et. al [10], the last two domains (knowledge and comprehension) falls under low-order thinking skills, whereas the remaining domains fall under higher-order thinking skills. In the low-order thinking domain, the questions are asked such a way that the students answer the questions based on what they have learned exactly in the class room or theory subjects. It does not trigger his or her creative brain cells. Therefore, in this domain region, memory of the studied materials are for only short-period of time. In other words, the materials discussed in this domain region are stored in the short-term memory of the brain.

The student might forget the studied materials after a semester or so. However, when the questions are asked based on higher-order thinking domains, then the students would have the ability to apply the knowledge they have learned in the classroom or theory subjects. This type of teaching would trigger the student's creative brain cells. Therefore, in this higher-order thinking domain region, the students would able to remember the studied materials for a long-period of time or forever. In other words, the materials discussed in these domain regions are stored in the long-term memory of the brain.

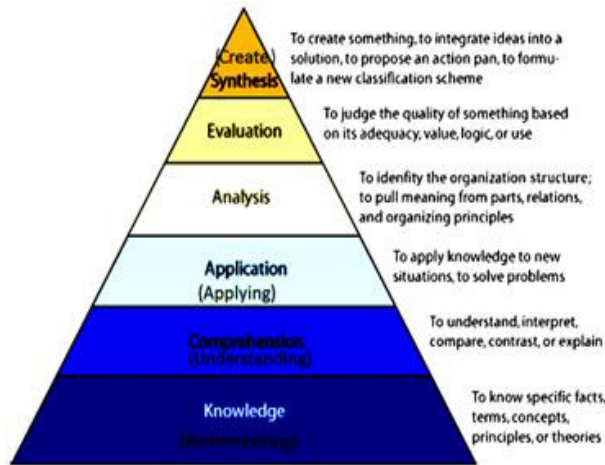


Figure 3: Revised Bloom's Taxonomy Pyramid

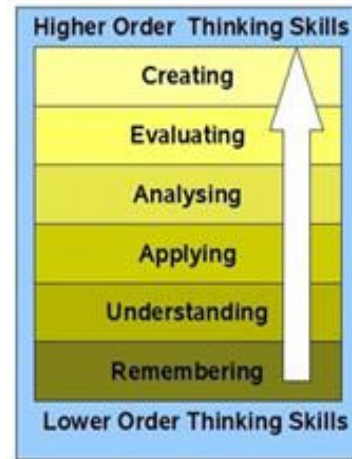


Figure 4: Revised Bloom's Taxonomy in Terms of Thinking Skills

Table 3 depict the type of word (verb) by each domain of revised Bloom's taxonomy could be used while setting up the question papers. The idea here is to make the question (verb) such a way that the students are able to trigger his or her creative brain cells to answer the questions. This is one of ingredients to create a smart student by an educational institution.

Table 3: Possible Verb's to Use for Different Domains of Bloom's Taxonomy

Domain	Possible Verb's				
Knowledge	Define	Describe	Identify	Know	Label
	List	Match	Name	Outline	Recall
	Recognize	State	Select	What	Which
	How	Give	Get	Brief	
Comprehensive	Comprehend	Convert	Defend	Distinguish	Estimate
	Explain	Generalize	Interpret	Extend	Give an example
	Predict	Infer	Summarize	Rewrite	Translate
	Mention	Comment			
Application	Apply	Change	Compute	Construct	Demonstrate
	Discover	Manipulate	Modify	Operate	Predict
	Prepare	Relate	Produce	Show	Solve
	Determine	Use	Derive		
Analysis	Analyze	Break down	Compare	Contrast	Deconstruct
	Diagram	Differentiate	Discriminate	Identify	Distinguish
	Illustrate	Infer	Outline	Relate	Select
	Separate	Why	Draw		
Evaluation	Appraise	Compare	Conclude	Contrast	Criticize
	Critique	Defend	Describe	Evaluate	Discriminate
	Explain	Interpret	Justify	Relate	Summarize
	Support	Specify			
Synthesis	Categorize	Combine	Compile	Compose	Create
	Devise	Design	Explain	Generate	Modify
	Organize	Plan	Rearrange	Reconstruct	Relate
	Reorganize	Revise	Rewrite	Summarize	Tell
	Write				

CASE STUDY

For this case study, the examination question papers of department of mechanical engineering of one of the best institutions in India (Top 20 best institution) were compared against the department of mechanical engineering of one of the best institutions in USA (Top 20 best institution). The institution in India is always keen in looking for new teaching

methodology to improve its teaching aids. The college spends a huge amount of time and resources on their faculty for continuous improvements in teaching. Most of the faculty in department of mechanical engineering was trained in active and student centric learning. The question papers were always setup as per revised Bloom's taxonomy approach. In addition, the department has created a question paper scrutiny committee, where the examination question papers are periodically audited. Moreover, the department often compares its question papers with other well recognized institutions around the world.

For this study, a total of 68 question papers (44 question papers were selected between December 2010 and March 31, 2011; and 24 question papers between June 2012 and November 2012) from the institution in India, and 7 question papers (between April 2004 and January 2006) from the institution in USA were analyzed. A gap analysis was conducted based on revised Bloom's taxonomy. To avoid any biased conditions, the question papers of both the institutions were reproduced in a same format with institution names hidden. The question paper scrutiny committee evaluated these question papers as per Bloom's taxonomy approach. Figure 5 illustrates the result of this study in the two engineering institutions.

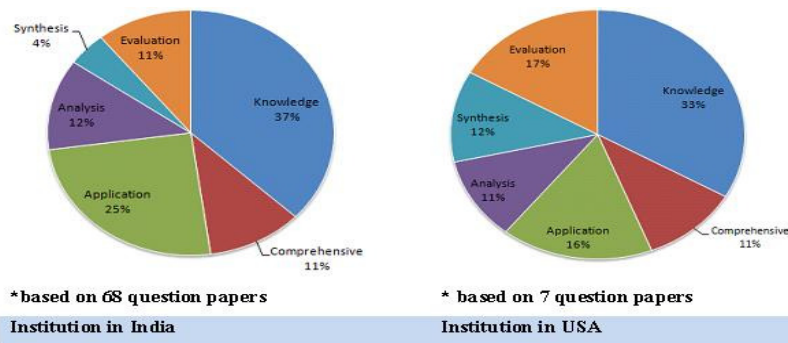


Figure 5: Gap Analysis of Bloom's Taxonomy Approach of Question Papers Setup

RESULTS AND DISCUSSIONS

Table 4 narrates the findings of this case study. From this table, it is interesting to note that both the institutions utilized low order thinking skills (understanding and analysis domains) well. In knowledge and application domain area, the institution in India had a slight edge over the institution in USA. The reason could be because the institution in India has an integrated industrial institute where all the students in mechanical engineering department have hands-on-training with industrial applications. In addition, the institution has tied-up with several local and global industry collaborations. However, in high order thinking skills (evaluation and create domains), the institution in USA has an edge over the institution in India. This could shows that students at the institution in India could be struggling in answering the higher order thinking skills questions or faculty were not setting up the question papers in these domains. In other words, it is an opportunity for the institution in India to improve.

Table 4: Narration between Two Prominent Institutions Based on Revised Bloom's Taxonomy

Revised Bloom's Taxonomy Domains	Institution in India	Institution in USA
Knowledge	37%	33%
Understanding	11%	11%
Application	25%	16%
Analysis	12%	11%
Evaluation	11%	17%
Synthesis/Create	4%	12%

CONCLUSIONS

From this study, it was observed that both the institutions utilize revised Bloom's taxonomy approach in setting up question papers. However, the usage of each domain of revised Bloom's taxonomy varies between the institutions. Following recommendations could be considered for the institution in India: (a) The institution shall continue as usual in setting up the question papers in low-order thinking skills (knowledge and understanding domains); (b) Even though the institution was performing well in application and analysis domains, it is important to concentrate to do better in these domains; and (c) The institution did very poorly in setting up the question papers in high-order thinking skills (evaluation and synthesis domains). The faculty may be trained in setting up questions that test the higher order thinking skills.

The outcome of an improvement in student's IQ could lead to: job opportunities, entrepreneurship, industry ready candidates, to name a few. The institution in USA complements this statement by producing more entrepreneurs and places their students in well reputed industries (for job seekers) each year. This could be because of their teaching methodology where higher order thinking skills of revised Bloom's taxonomy are imparted to their students. This could be achieved only with the help of faculty. Therefore, institutions which lack in higher order thinking skills are to take necessary steps to improve in this arena by offering more training to the faculty.

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