

Human Input Measurement Methodology for Engineering Education

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Abstract

Human input measurement in service sector is really a different task. As the service organizations are concerned with the 'processes' (and not the 'products'), their performances are linked with the efficiencies of the input resources. A process, as in the case of engineering education, may have numerous inputs. The output, that is performance, of such a system is based on the complex interactions between these inputs. The present paper is an attempt toward the development of a methodology for the measurement of performance levels of the teacher's attributes as the input parameters. The paper, it is believed, can provide the important guidelines to all those who are concerned with evaluation & performance improvement of the engineering education.

Key Words: Teacher's attribute, point values, attribute level quotients, attribute quotients, overall quotient.

Introduction

Human asset is the key input factor decisive for the output of education system. Measurement of the attributes of human asset is difficult since it has many facets to consider. However, performance evaluation is the basic step for productivity improvement and as such, there is a strong need of a methodology that could measure the input levels of various human attributes objectively. The present study is about a unique methodology, developed through serious thought and mature deliberation, for the measurement of teacher's attributes.

Inputs to engineering education

The technical education system achieves the transformation of the students into technically qualified human resource through a conversion process called as teaching learning process.

The objective of teaching-learning process is to transfer the knowledge in some specified areas by various methods. The effectiveness of the teaching-learning process is the function of many input factors, to name few are: men (faculty, supporting staff, hired experts, etc.) machines (laboratory/workshop equipments, teaching aids, organizational aids, office equipments, etc.), methods (teaching & laboratory instructions, tutorials, case studies, seminars, projects, industrial visits, etc.), infrastructure and other facilities (building, classrooms, library, internet, etc.), etc.

Teacher is at the pivot of teaching-learning process. Teachers shape the future of students. Students follow teachers as their role models, and imitate their ethics and values. To satisfy the goal of knowledge transfer effectively and efficiently, the teacher should be a qualified

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teacher. Qualified teacher is one who possess the required knowledge, skills and other attributes (physical & mental) needed to teach the specified subject at the stated level of performance.

Attributes of Teacher

Four important attributes identified for teachers are:

1. **Knowledge (K):** It refers to a body of knowledge gained through formal education, experience, and self study.
2. **Skill (S):** It refers to proficiency at following the standard method. Skill is about coordination of mind and body and therefore, it is responsible for the effectiveness of the process.
3. **Performance (P):** It refers to the timely and orderly execution of their assigned or self-initiated task to meet the specified objectives.

4. **Behaviour (B):** It refers to the physical expression of feeling, emotions and thought reflecting ethics and social values. Teacher's behaviour greatly affects the state of mind of the students.

The Measurement Methodology

The scheme for measurement of teacher's input, based on the four attributes mentioned above, is presented in Table 1 through Table 4. Each attributes has two levels: Basic & Specific. Basic levels of attributes are meant for junior teachers while specific levels of attributes are meant for senior teachers. Further, each attribute is divided into sub-factors. Each attribute & its sub-factors have point values (PVs) (enclosed in II) associated with them. Three degrees – Degree 1 (best range), Degree 2 (mediocre range) and Degree 3 (worse range) – are specified for each sub-factor. PV range are mentioned for each degree

Table 1 : Evaluation of Knowledge Attribute

Attribute	Sub-factors	Degree		
		1	2	3
Specific Knowledge (BK) [100]	BK1: Depth of the subject [80]	Superficial [0-26]	Moderate [27-53]	Deep [54-80]
	BK2: Depth of other related subjects [10]	Superficial [0-3]	Moderate [4-7]	Deep [8-10]
	BK3: Industrial Exposure@ [10]	<2 yrs [0-3]	2-5 yrs [4-7]	> 5 yrs [8-10]
	SK1: Additional Qualification in related area [20]	Degree/Diploma [0-6]	Post-graduation Highly specialized course [7-14]	Eminent Research/Ph.D [15-20]

Attribute	Sub-factors	Degree		
		1	2	3
Specific Knowledge (SK) [100]	SK2: Periodic updates (STTPs/Specialized courses/Workshops etc.) @ [20]	Zero-One-Two weeks in three years [0-6]	One-Two Week in two years [7-14]	One-Two weeks in a year [15-20]
	SK3: Consultancy/ Industrial projects @ [15]	Rare [0-5]	Sometimes [6-10]	Appropriate [11-15]
	SK4: Publications: Interanational Journal @ [15]	1 or more / three year/Nil [0-5]	1 or more / two year [6-10]	1 or more / year [11-15]
	SK5: Publications: National Journal @ [10]	1/three year/nil [0-3]	1/two year [4-7]	1/year [8-10]
	SK6: Publications: Books @ [10]	Nil/1 Local (Notes) [0-3]	1 National [4-7]	1 International 2 National [8-10]
	SK7: R & D / Patents @ [10]	Low-promising [0-3]	Promising [4-7]	Highly promising [8-10]

@ in subject related areas

Table 2 : Evaluation of Skill Attribute

Attribute	Sub-factors	Degree		
		1	2	3
Basic Skill (SS) [100]	BS1: Delivery skills [80]	Poor [0-26]	Medicore [27-53]	Excellent [54-80]
	BS2: Control skills [20]	Poor [0-6]	Good [7-14]	Excellent [15-20]
	SS1: Delivery medium [30]	Traditional [0-10]	Role plyaing [11-20]	Multimedia [21-30]
	SS2: Group exercises/ Case Studies [20]	Rare [0-6]	Occassional [7-14]	Frequent [15-20]

Table 2 : Evaluation of Skill Attribute

Attribute	Sub-factors	Degree		
		1	2	3
Specific Skill (SS) [100]	SS3: Teaching notes [20]	Nil/Few topics [0-6]	Some topics [7-14]	Complete [15-20]
	SS4: Use of teaching aids [10]	Rare [0-3]	Occasional [4-7]	Frequent [8-10]
	SS5: Students interactions [10]	Rare [0-3]	Occasional [4-7]	Frequent [8-10]
	SS6 : Field/Industry Visits [10]	Rare [0-3]	Occasional [4-7]	Frequent [8-10]

Table 3 : Evaluation of Performance Attribute

Attribute	Sub-factors	Degree		
		1	2	3
Basic Performance (BP) [100]	BP1: Syllabus coverage [20]	<50% [0-6]	50-80% [7-14]	> 80% [15-20]
	BP2: No. of periods engaged [20]	< 50% scheduled period [0-6]	of 50-80% of scheduled period [7-14]	> 80% of scheduled period [15-20]
	BP3: Regularity to lecture [10]	Low (Always adjust lecture) [0-3]	Moderate (Sometimes adjust lecture) [4-7]	High (Rarely adjust lecture) [8-10]
	BP4: Punctuality [10]	Low (Always Late) [0-3]	Moderate (Sometime late) [4-7]	High (Rarely late) [8-10]
	BP5: Student's evaluation [10]	Rare [0-3]	Sometimes [4-7]	Always [8-10]

Attribute	Sub-factors	Degree		
		1	2	3
	BP6: Co-curricular & Extra-curricular activities [10]	Rare [0-3]	Sometimes [4-7]	Always [8-10]
	BP7: Students counseling & motivation [10]	Rare [0-3]	Sometimes [4-7]	Always [8-10]
	BP8: Library development [10]	Rare [0-3]	Sometimes [4-7]	Always [8-10]
Basic Behaviour (BB) [50]	SP1: Initiatives Arranging extra lectures, guest lectures, etc. [10]	Low [0-3]	Moderate [4-7]	High [8-10]
	SP2: Initiatives Arranging Conferences (national/international), workshops(<1 week) etc. [10]	Low [0-3]	Moderate [4-7]	High [8-10]
	SP3: Initiatives: Arranging training Programs (>1 week) etc. [10]	Low [0-3]	Moderate [4-7]	High [8-10]
	SP4: University assignments [30]	Rare [0-9]	Sometimes [10-20]	Always [21-30]
	SP5: Laboratory development [20]	Low [0-6]	Moderate [7-14]	High [15-20]
	SP6: Curriculum development [10]	Low [0-3]	Moderate [4-7]	High [8-10]
	SP7: Development of new experimental set-up [10]	Rare [0-3]	Sometimes [4-7]	Always [8-10]

Table 4: Evaluation of Behaviour Attribute

Attribute	Sub-factors	Degree		
		1	2	3
Basic Behaviour (BB) [50]	BB1: Student's friendly [10]	Rare [0-3]	Sometimes [4-7]	Always [8-10]
	BB2: Sincerity [10]	Poor [0-3]	Good [4-7]	Best [8-10]
	BB3: Discipline [10]	Loose [0-3]	Moderate [4-7]	Strict [8-10]
	BB4: Assistance in administration [10]	Rare [0-3]	Occasional [4-7]	Frequent [8-10]
	BB5: Ethics & Value [10]	Low [0-3]	Medium [4-7]	High [8-10]
Specific Behaviour (SB) [50]	SB1: Overall orientation: Industry Liasison [10]	Poor [0-3]	Good [4-7]	Best [8-10]
	SB2: Overall orientation: Alumni contacts [10]	Poor [0-3]	Good [4-7]	Best [8-10]
	SB3: Overall orientation: Social responsibility [10]	Poor [0-3]	Good [4-7]	Best [8-10]
	SB4: Overall orientation: Other organizations [10]	Poor [0-3]	Good [4-7]	Best [8-10]
	SB5: Cohesiveness [10]	Low [0-3]	Medium [4-7]	High [8-10]

Table 5 shows the minimum acceptable PVs for teachers at different stages. As the specific levels of attributes are important for senior

teachers, their acceptable values at lower stages are kept low.

Table 5 : Minimum acceptable PVs (Stage-wise)

Attribute		Minimum acceptable PVs							
		Stage 1 (Experience < 5 yrs)		Stage 2 (Experience = 5-15 yrs)		Stage 3 (Experience = 15-30 yrs)		Stage 4 (Experience > 30 yrs)	
BK	K	65	90	75	110	85	135	90	155
SK		15		25		45		55	
BS	S	50	85	65	110	80	140	90	160
SS		25		35		50		65	
BP	P	60	90	70	120	80	150	90	170
SP		20		40		60		70	
BB	B	25	40	30	55	35	70	40	80
SB		10		20		30		35	
Total			305		395		495		560

The Evaluation

The evaluation of teacher's attributes can be made by following three types of quotients:

- Attribute Level Quotient:** Eight attribute level quotients, one for each level of attributes, i.e., Basic Knowledge Quotient (Qbk), Specific Knowledge Quotient (Qsk), Basic Skill Quotient (Qbs), Specific Skill Quotient (Qss), Basic Performance Quotient (Qbp), Specific Performance Quotient (Qsp) and Basic Behaviour Quotient (Qbb) and Specific Behaviour Quotient (Qsb).

Attribute Level Quotient = (PVs earned for the attribute level) / (Maximum PVs for the attribute level)

- Attribute Quotient:** Four attribute quotients, one for each attribute, i.e., Knowledge Quotient (Qk), Skill Quotient (Qs), Performance Quotient (Qp) & Behaviour Quotient (Qb)

Attribute Quotient = (PVs earned for the

attribute) / (Maximum PVs for the attribute)

- Overall Quotient:** The stage-wise overall quotients (Qo) give total evaluation of a teacher.

$Q_s = (\text{PVs earned for all the attributes}) / (\text{Maximum PVs for all the attributes})$

The evaluation should be made in right environment. There should not be pressure of management, principal, HOD, students or any other external or internal factor. The teaching and other load must be as per AICTE norms. Adequate teaching facilities must be available. In fine, the teacher must be free from any stress. The student's feedback and self-appraisal form of the teacher should be used as a basis for evaluation.

A Hypothetical Case

Prof. Adhyapak, Lecturer in Mechanical Engineering, has two years industrial and 12 years teaching experience. With his post-graduation in Mechanical Engineering, Prof.

Adhyapak also did one-year diploma in Tool Design. In last three years, he attended two-week training programmes & published three papers in national journal. In his career, he has successfully completed a consultancy project of six-month duration. Prof. Adhyapak is popular among the students because of his delivery skills, subject notes & student-friendly behaviour. However, he uses to stay with specific colleagues in his department. He organized blood donation camps thrice, headed a meeting for curriculum development, chaired a committee for annual

social gathering and assisted superiors many times to prepare for review committees. Recently, he has started research on Turbomachinery. Most of Thermal Power Laboratory and developed two new set-ups in last three years.

After careful study of the bio-data and self-appraisal form of Prof. Adhyapak & after mature discussion with and feedback from the students and colleagues, Evaluation Committee allotted the PVs & estimated quotients as shown in Table 6.

Table 6: PVs Earned & Quotients in a Hypothetical Case

Sub factors	PVs earned	Sub factors	PVs earned	Sub factors	PVs earned	Sub factors	PVs earned
PVs earned	68	BS1	65	BP1	16	BB1	9
BK2	6	BS2	10	BP2	16	BB2	7
BK3	4	Total : BS	75	BP3	7	BB3	6
Total: BK	78	SS1	16	BP4	7	BB4	9
SK1	12	SS2	11	BP5	8	BB5	8
SK2	7	SS3	16	BP6	5	Total: BB	39
SK3	4	SS4	10	BP7	8	SB1	5
SK4	0	SS5	8	BP8	7	SB2	6
SK5	9	SS6	4	Total:BP	74	SB3	7
SK6	0	Total:SS	65	SP1	4	SB4	6
SK7	1	Total: S	140	SP2	1	SB5	6
Total: SK	33			SP3	2	Total SB	30
Total : K	111			SP4	22	Total: B	69
				SP5	8		
				SP6	5		
				SP7	4		
				Total: SP	46		
				Total: p	120		
Q_{bk}	0.78	Q_{bs}	0.75	Q_{bp}	0.74	Q_{bb}	0.78
Q_{sk}	0.33	Q_{ss}	0.65	Q_{sp}	0.46	Q_{sb}	0.60
Q_k	0.56	Q_s	0.70	Q_p	0.60	Q_b	0.69
Q_o (Stage 2) = (111+140+120+69) / 700 = 0.63							

As Prof. Adhyapak is at stage 2 (experience = 5-15 yrs), minimum acceptable PVs are: BK = 75, SK = 25, K = 110, BS = 65, SS = 110, BP = 70, SP = 40, P = 120, BB = 30, SB = 20 & B = 55. For all attributes, the PVs earned by Prof. Adhyapak are in satisfactory ranges. However, he is about to move in stage 3, and therefore, he must improve in attributes K & P, for which his present PVs are at threshold.

Conclusion & Future Scope

The methodology suggested helps to evaluate the performances of the teachers objectively. The Qo gives the level of performance of an individual teacher. The attribute quotients help to decide the weaker attribute so that the teacher can take efforts to improve upon it. The sub-factors may be further divided & appropriate PV may be assigned to them. Similar quotients may be calculated for other input factors, viz. machines, methods, infrastructure, etc., by identifying the attributes and assigning the PVs. Overall system quotient may then be estimated for entire education system. Similar exercise may be carried for output (i.e. qualified human resource) and both the quotients may be compared to estimate the performance index of the educational organization.

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