

Incorporating Critical Thinking Skills in the Technical English Curriculum of Engineering Learners: A Needs Analysis

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Abstract

The employment scenario in the engineering domain has changed profoundly in the past few decades. Employers prefer engineers who think professionally, applying comprehensive intellectual standards. While seeking employment, engineering graduates are more often judged by their ability to think critically. As Critical thinking is considered a vital professional skill to be developed by the engineering students it should be incorporated in the engineering curriculum. Language and thinking are inseparable and interdependent. Language skills play a key role in processing the information in a critical perspective. Moreover, quality thinking helps individuals communicate skilfully in a variety of situations. English is learned as an applied language by the engineering learners. Hence, at the tertiary level the English language curriculum should provide scope for developing critical thinking skill of the learners by explicitly incorporating the objectives. This study seeks to identify the essential critical thinking components that can be infused into the Technical English curriculum in order to develop the critical thinking skills of the engineering learners. A questionnaire was administered, and the results adequately reflect the need to incorporate the components of critical thinking skills.

Introduction

Thinking is a natural process and plays a significant role in all aspects of life. The quality of our life depends on the quality of our thoughts. (Paul, Richard, and Linda Elder, (2006). Thinking, a mental process facilitates man, act in wide range of, simple to complex activities such as making a choice, judging, planning and executing, understanding and reasoning the concepts, questioning others opinion and challenging decisions. In this ever expanding, knowledge and technology driven global society, to profit from the opportunities, the engineering workforce is in need of a particular competency known as critical thinking. Individuals who have mastered the rudiments of critical thinking will be able to sift through and analyse a wide range of available information and make effective decisions and resolve conflicts efficiently which are integral part of engineering profession.

Critical Thinking Skills for Engineers

For engineers, the employment landscape has changed a lot in the past few decades. The emerging trends in the engineering sector are highly challenging and competitive. Engineers are expected to think professionally applying comprehensive intellectual standards. Bloom (1956) has elaborated on key thinking skills, termed as Bloom's Taxonomy. The levels of cognition are classified as lower order thinking skills (remember, understand and apply) and higher order thinking skills (analyze, evaluate and create). The integrated use of these six skills will definitely promote critical thinking. According to Facione (1998) critical thinking is a liberating force in education and a powerful resource in one's personal and civic life. Critical thinking skill is essential in every domain of learning. Critical thinking refers to higher order thinking that questions assumptions (Brookfield, 2000). Engineering graduates while seeking employment are more often judged by their ability to think critically. Many engineering graduates are considered incompetent as they lack reasoning and higher order thinking skills. Hence, engineering professionals should be equipped with skills such as critical and creative thinking, problem solving and managing people which are relevant to their job industry.

At tertiary level the learners' level of learning should not be the objective of assessment but the learners should be equipped to assess their own thinking (Stone, 2001). David T. Conley (2008) finds that "habits of mind" such as — "analysis, interpretation, precision and accuracy, problem solving, and reasoning" can be as or more important than content knowledge in determining success. Critical thinking is a key skill which engineering students should develop as they need to internalize the content by understanding the underlying principles, ideas and theories and apply the internalized knowledge in relevant places and at relevant time. Also, higher order thinking skills are necessary for the learners to form critical perspectives on principles and theories of engineering and technology. In the engineering discipline both the learners and the professionals cannot accept all the information, ideas, findings or conclusions ostensibly. The students at tertiary level when presented an oral or written text should comprehend the meaning of the text, distinguish the facts from opinion and identify the supporting evidences. Further, they should reflect on the quality of the reasoning process using the higher order thinking skills such as analysis, synthesis and evaluation. The scientific experiments are always endowed with critical thinking and problem-solving activities. Problem solving and making decisions are essentially a major part of engineers' profession. The process of solving problems involves a series of steps such as defining the problem, framing an explanatory hypothesis, analysis and interpretation of data, arriving at a conclusion and reporting.

Moreover, the engineering professionals work in a global setting and need to communicate in multicultural context. As they climb the professional ladder, the tasks are people oriented. Working in a team or managing a team is very common in engineering world. Professionals need to build positive relationships with people in the organization and other stakeholders. Apart from the resolving technical problems the professionals should also equip themselves with the skills to resolve conflicts arising in a team or among employees. Effective decisions with sound thinking skills will bring harmony in the organization

Thinking Skills in Technical English Curriculum

The engineering students learn English as an applied language. The learners will most likely use the English language in their future jobs where communication is vital for professional development. Engineers, on a number of occasions, have to express their ideas persuasively and convincingly to others. While the engineering professionals engage in complicated tasks, discussing complex and abstract ideas necessitates strong linguistic ability to express the complexity of their thinking in depth. With deficient language skills learners and professionals could not comprehend and process the information and articulate their ideas efficiently. Language skills play a key role in processing the information in a critical perspective and quality thinking helps individuals communicate skilfully in a variety of situations. The noted Swiss psychologist, Jean Piaget (1926) believed that thought not only determines language, but also precedes it.

Language acts as a medium for learning and thinking. It gives shape to thoughts and ideas. Language and thinking are inseparable and also interdependent. The engineering professionals who possess good discourse skills in the target language aligned with sound critical thinking skills can navigate seamlessly in their professional life. The learners should reflect on their own learning and engage with the information they receive from various sources, evaluate and make choice. The learners both during the course of study and later in their career have to present arguments effectively and defend their ideas with supporting evidences in a variety of situations and persuade and convince a wide range of audience. Language proficiency is not only understanding a variety of text and lectures and producing grammatically correct sentences with rich vocabulary but also exhibiting the creative and critical thinking ability.

Thinking is essentially the mental process that facilitates individuals listen actively, read attentively, speak mindfully and write thoughtfully. English language curriculum for engineering learners should provide space for the development of the thinking skills along with the listening, speaking, reading and writing skills. Language classrooms are not for only imparting the mechanics of the language through repeated drills of isolated grammatical structures but for also developing higher order thinking ability by focusing on the meaning of the content. English language teaching can be linked with thinking skills through problem solving tasks. Stimulating the cognitive processes, problem solving is introduced as the main pillar of thinking skills in the literature of thinking skills in EFL/ESL contexts (Sokol et al, 2008).

The engineering and technology students are exposed to a variety of concepts and expertise of learners in language and thinking skills would help them navigate seamlessly in academic and professional pursuits. The learner should remember concepts and should be in a position to recall facts and figures. With the available input, the learner should interpret and translate and summarize a given set of details. He should also use information in a situation different from the original learning context. The learners should also be able to identify and analyse the part whole relationship and whole part relationship. Given a set of details or data, the learner should be able to manipulate the given elements to create a new entity for the given set of details. Finally, the learner should also be able to judge, assess and evaluate based on a rationale or evolved criteria. With these critical thinking

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components framed as explicit objectives of the English language curriculum, the ESL teacher can act as a catalyst and bring about a positive change in the behaviour of the learner.

Language teachers can foster thinking environment in the classroom by engaging the learners in a wide range of critical thinking activities. Assigning problem solving activities to the teams will trigger metacognition and promote critical thinking skills (Ryder, 1994). With a variety of materials and related tasks the ESL teachers should encourage the learners to challenge and query the supposition and explore the complex issues in depth in order to foster the critical thinking ability. Communication and critical thinking are interconnected strands. Soliciting answers for probing questions and seeking logical and insightful answers in the target language make the learners use the language meaningfully and purposely. While pondering deeply over assigned tasks the learners tend to use all the language skills in the process. By using the target language in a meaningful context the learners also develop language ability.

The technical English curriculum for the engineering discipline should focus on developing the communication skills and promote higher order thinking skills of the learners to meet the industrial expectations. As discussed earlier, thinking is fundamental and core element of effective communication and also an important trait expected by the employers. Hence, thinking skills should be made an integral part of the curriculum by framing explicit objectives.

Needs Analysis

The effectiveness of the curriculum and instructional approaches are based on identifying the needs of the learners during the course of study and later to meet on the job requirements. Only a sound understanding of learner needs can contribute to successful course planning. The process also sometimes involves, looking at the expectations and requirements of employers. Since, learning a language is not just a mental process but a process of negotiation between individuals and society, the conclusions of needs analysis in EAP are constantly checked and re-assessed according to individual and social changes (Hutchinson and Waters, 1987). The identified needs of the learners should be incorporated explicitly in the form of objectives in the curriculum. Objectives are important guide to plan and implement the appropriate instructions, design a range of suitable tasks and assess the level of attainment of the learners. The information gathered from needs analysis can be used to define the objectives of the curriculum which in turn will function as the foundation to develop the course materials.

Methodology

The thinking skills essential for the engineering learners were identified through unstructured interviews and informal discussions with the English language and other subject teachers of various Engineering Colleges and classroom observations. The need analysis questionnaire with thinking skills as inputs was administered to 200 participants (50 students of the various engineering colleges situated in urban and rural areas, 50 English language teachers and 50 other subject teachers of various Engineering Colleges and 50 employees of Multinational companies).

Result and Discussion

The results of needs analysis survey on thinking skills obtained from students, English language teachers, subject teachers from engineering colleges and employees from multinational companies are presented in the Table 1 and 2. The pictorial representations of feedback analysis of students, English language teachers, subject teachers and employees are given in Fig. 1, 2, 3 and 4 respectively. A scrutiny of the survey adequately reflects the need to incorporate the sub skills of critical thinking as a part of Technical English curriculum. The responses obtained pertaining to the specific thinking skills to be acquired is highly affirmative. A considerable number of participants have agreed that constructing the meaning from the context and with global comprehension, recognizing the text organization and distinguishing facts from opinion are important skills to be developed. Relatively a high number of participants are of the view that making close analysis of the available details, synthesizing the information with prior knowledge, assessing the force of argument and conclusiveness of the evidence and making inferences are essential thinking skills. Identifying and defining the problem that requires solution, diagnosing the weakness, constraints and making out alternative solutions synthesising the information at hand and information gathered over years are also rated as indispensable thinking skills. The response also reflects the importance of finding an ideal solution pertaining to the situation and presenting in either spoken or written form or both. From the findings, it is evident that acquiring the nuances of thinking skills is considered very much essential. These skills as part of major inputs would complement the mastery of language skills apart from enhancing the higher order thinking skills of the learners.

**Table 1: The Results of Needs Analysis Survey on Thinking Skills
Obtained from Students and ESL Teachers**

S. No.	Objectives	Students				ESL Teachers			
		Rating Scale				Rating Scale			
		1	2	3	4	1	2	3	4
1	think critically and objectively on listening to a lecture or reading any material	38	9	2	1	42	7	1	0
2	identify the key-words	35	12	3	0	39	10	1	0
3	constructing the meaning with context clues	32	12	4	2	37	9	2	2
4	perceive the way a text is organized (part-whole and part-part relationships of facts, arguments and generalizations)	36	11	1	2	45	3	1	1
5	understand with global comprehension or overall	35	11	2	2	40	8	1	1

	organization of ideas								
6	segregate and assimilate all information gathered	30	15	3	2	34	12	3	1
7	assess the details and discriminate facts from opinions	29	16	2	3	38	11	0	1
8	make a systematic close analysis of the details presented	22	18	5	5	27	14	6	3
9	create mind maps	15	20	1 2	3	34	13	3	0
10	assess the force of an argument or the conclusiveness of evidence	43	2	4	1	29	16	4	1
11	make inferences	13	22	1 0	5	41	2	4	3
12	evaluate the content and respond according to the context /need	40	8	1	1	29	16	2	3
13	identify any problem which requires a solution	27	14	6	3	36	10	2	2
14	diagnose the weakness/es in the system and	32	12	5	1	38	11	1	0
15	identify the constraints	34	6	5	5	39	9	2	0
16	synthesize all information gathered over years for the present day use	23	14	9	4	27	15	5	3
17	identify alternative solutions	25	22	3	0	21	18	7	4
18	make a selection of an ideal solution/ a working model	35	5	7	3	46	3	1	0
19	prepare a logically acceptable response and	36	12	1	1	27	14	7	2
20	present in the form of a spoken and written word	25	18	6	1	48	2	0	0
	Average score	30	13	5	2	36	10	3	1

*Rating Scale: 1- Excellent, 2 – Very Good, 3- Good, 4 - Fair

**Table 2: The Results Of Needs Analysis Survey on Thinking Skills
Obtained from Subject Teachers and Employees**

S. No	Objectives	Subject Teachers				Employees			
		Rating Scale				Rating Scale			
		1	2	3	4	1	2	3	4
1	think critically and objectively on listening to a lecture or reading any material	39	8	2	1	36	10	2	2
2	identify the key-words	37	8	4	1	34	10	3	3
3	constructing the meaning with context clues	41	6	1	2	43	4	2	1
4	perceive the way a text is organized (part-whole and part-part relationships of facts, arguments and generalizations)	41	6	3	0	44	3	0	1
5	understand with global comprehension or overall organization of ideas	32	14	3	1	45	2	2	1
6	segregate and assimilate all information gathered	36	11	3	0	39	6	2	3
7	assess the details and discriminate facts from opinions	25	19	4	2	18	22	6	4
8	make a systematic close analysis of the details presented	25	10	12	3	34	13	3	0
9	create mind maps	31	11	5	3	36	9	4	1
10	assess the force of an argument or the conclusiveness of evidence	25	16	7	2	31	10	7	2
11	make inferences	23	17	6	4	35	8	4	3
12	evaluate the content and respond according to the context /need	29	16	4	1	38	11	0	1
13	identify any problem which requires a solution	22	18	5	5	34	12	3	1

14	diagnose the weakness/es in the system and	35	11	3	1	41	4	3	2
15	identify the constraints	41	5	3	1	36	8	4	2
16	synthesize all information gathered over years for the present day use	33	11	5	1	38	6	4	2
17	identify alternative solutions	31	6	11	2	25	14	8	3
18	make a selection of an ideal solution/ a working model	32	14	4	0	43	4	3	0
19	prepare a logically acceptable response and	23	17	7	3	17	18	9	6
20	present in the form of a spoken and written word	41	6	3	0	43	6	1	0
	Average score								
	Average score	32	11	5	2	37	7	4	2

*Rating Scale: 1- Excellent, 2 – Very Good, 3- Good, 4 - Fair



Fig. 1: Pictorial Representation of Feedback of Students of Engineering Colleges



Fig. 2: Pictorial Representation of Feedback of English Language Teachers of Engineering Colleges

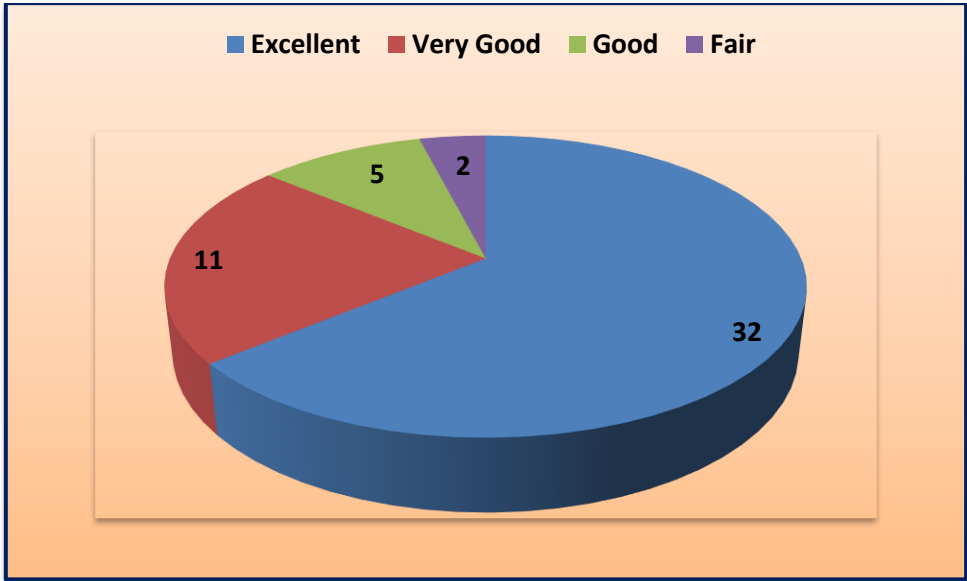


Fig. 3: Pictorial Representation of Feedback of Subject Teachers of Engineering Colleges



Fig. 4: Pictorial Representation of Feedback of Employees of Multinational Companies

Conclusion

Curriculum is a statement of the educational purpose and objectives are the means to achieve the purpose. Learning objectives are the statements that describe what the learners will be able to do upon the completion of the course. The objectives of the curriculum should be directly relevant to the needs of the learners while undergoing the course of the study and later to meet, on the job requirements. To meet the complex academic and professional demands the learners should be equipped with necessary thinking and associated language skills. This could only be achieved by incorporating the components of critical thinking skills in the form of objectives and embedding the necessary instructions and related tasks in the English curriculum for engineering learners.

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