Critical Thinking Process and Its Effect on Engineering

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Abstract

Critical thinking is the efficient and active process of synthesizing, analysing, integrating, conceptualizing, or/and evaluating knowledge produced or obtained by communication, reason, reflection, experience, or observation as a guide to action and belief. The effect of one point is determined by the reactions of others. When building arguments, highly practicing thinkers see the invalidity of their theories as a result of criticisms of others as well as possible refutations of their own. Communication, both external and internal, is a process that makes someone new while undergoing development. This technique can help to clarify the definition of critical thinking as a theoretical concept, a quantitative skill, as well as an educational objective, and therefore as a theoretical concept, a quantitative skill, and an instructional objective. We examined several perspectives and stages of critical thinking, such as observation, analysis, and communication, in this study. Critical thinking is an intellectual endeavour in which students learn to identify or construct an argument, use evidence to substantiate that argument, draw appropriate conclusions, and use knowledge to solve problems.

Keywords: analysis, communication, critical thinking, management, stress level

1. Introduction

Critical thinking is the process of evaluating available facts, evidence, observations, and arguments in order to reach a conclusion. The topic is complicated; there are various definitions, but they all contain a reasonable, sceptical, and impartial investigation or assessment of factual facts. Self-directed, self-disciplined, self-monitored, and self-corrective thinking are all characteristics of critical thinking. It requires agreement with strict criteria of excellence and a conscious command of their application. It requires strong communication and problem-solving skills, as well as a dedication to overcoming egocentrism and sociocentrism in one's natural state. The Accreditation Board for Technical and Technology, for example, recognizes the need of combining critical thinking (CT) education with other fundamental engineering capabilities in engineering curricula (ABET). The value of CT capabilities is emphasized by companies in these engineering-related care categories. These abilities, on the other hand, are not usually engrained in engineering graduates. In those focus groups, it was also observed that, although the students' technical abilities were strong, their CT skills, in particular, were not sufficiently addressed. CT is seen as a significant undergraduate trait by engineering organizations and academics, according to previous surveys. However, found that engineering academics were less certain about describing struggled to clarify what he meant by CT (D. Adair and M. Jaeger 2016, N. Kumar and R. Tyagi 2019, N. Jain and Y. Awasthi 2019)

An engineer's ability to solve issues in the workplace is unique of the abilities prized through the occupation market and employers Engineers may face a variety of obstacles at work, including technical issues as well as issues with human connections. For example, according to “conflicting aims, numerous solution methodologies, are all examples of collaborative activity., point out, engineering students struggle to address dire sustainability issues such as climate change, deficiency and reserve shortage. They don't have the right tools to deal with the complexity, unpredictability, and value struggles that come with these circumstances (S. Kumar, A. Kumar, and M. M. Khan 2019).

Problem-solving in work is as much a social as a technical activity. For engineering dynamics in problem solving and

knowledge creation, practical skills, relational skills, social skills, management, and incentive are significant. Researchers believes that coordinating and collaborating technical work with others are important parts of engineering practice, and a methodical method to manufacturing teaching that encourages the growth of requisite abilities is needed. Because of these aspects of workplace difficulties, engineering education programs should take into account the physiognomies of real-world challenges and incorporate problem-based knowledge methods and settings (S. K. Patnaik 2019).

The relationship among CT and engineering problematic resolving is a common topic in the works. This requires a review of the available data and following assessment of the choices made. Notwithstanding the apparent relevance of CT in engineering teaching, here is currently a limited number of studies on the subject. Instead, Claris and Riley correlate the debate about CT in engineering with instructional techniques that deal with problem (L. Claris and D. Riley 2012). However, engineers need to achieve CT capabilities combined with more systematic thinking to cope with the changing environment. The quality of what engineers develop and what they the quality that their thinking and thus the manner they think determines what they generate. CT learning/learning, in this approach, entails defining problem-solving ideas, choosing challenges, among other things, interaction CT involves promoting temperament (N. Nainwal, R. Singh, S. Jawla, and V. A. Saharan 2019).

CT is defined as an "objective, self-regulatory decision that the In this case, skill and temperament can be used to interpret, analyse, evaluate, and infer evidence as well as evaluate the philosophical, methodological, or contextual components on which the judgment is founded. CT skills are a collection of abilities such as analysis, evaluation and translation that must be assessed to establish one's level of reasoning and understanding. Ability to self-improve. Curiosity, accessibility of mind, and other qualities or preoccupations are examples of Whistler temperament. Carefulness in decision making, and so on (N. Nainwal, R. Singh, S. Jawla, and V. A. Saharan 2019).

Reflective practice is a procedure of thoroughly examining a theme or situation using relevant data. Here are some common procedures when looking to answer an issue:

- Identify a problem.
- Comprehend the cause of a tricky and how to solve it.
- Investigate the problem and gather facts or information.
- Sort and organize your results and information.
- Create and insert action solutions.
- Test the successes and failures of different solutions.
- Determine how to improve the solution.

To be a competent critical thinker, you must be objective. It is analysing a subject on the basis of facts rather than feelings. Critical thinking abilities are required in all occupations and at all levels of employment. Good critical thinkers solve challenges both in groups and alone.

Critical thinking helps you make effective decisions in the workplace by helping you see potential obstacles and come up with their answer. It helps you and your co-workers to come up with new ideas and implement them to reach your goals. Critical thinking can help find and correct workflow inefficiencies, enhance management practices, influence financial decisions, and establish a strategy plan in practically every task.

Employers recognize the importance of critical thinking and seek people by critical thinking abilities to fill available jobs, thus focusing on employment through your individual critical thinking will help you develop your career, among other things.

- promote teamwork
- conflict resolution
- exercise leadership
- Time is money.

Critical thinking promotes communication by enabling individuals from different perspectives to share their knowledge and assess its effectiveness. To analyse a situation effectively, critical thinking requires looking at an issue from a variety of perspectives, making input from others an essential aspect of effort procedures.

1.1 Conflict Resolution

By recognizing how a scenario happened, recognising the consequences, and affecting forward with a solution-oriented perspective, you can use critical thinking to help moderate workplace conflicts. The analytical nature of critical thinking can help you remain objective when dealing with interpersonal issues without being bogged down by personal biases or prejudices. The aptitude to use critical thinking to solve one's own issues and help others in the workplace enhances the general environment and fosters a culture of responsibility and appropriate, polite dialogue.

You demonstrate that you are a good leader for strategic planning by thinking critically while meeting your professional obligations. Powerful critical processing is data-driven, giving you a summary of the problem you're trying to solve, possible solutions, and any other relevant information. Displays leadership by taking all of these factors into account to make a well-informed decision and thus demonstrates the ability to use specifics to achieve a larger vision or objective.

1.2 Time Is Money

Critical thinking can help you save time in the long run by helping you prioritize tasks and identify relevant resources and information. It helps you to make well informed decisions which are more likely to result in the desired outcome. Conclusion, as well as reduce the time and effort spent making revisions and reacting to unexpected scenarios. Despite expanded recent efforts to apply a variety of instructional design approaches to better promote the critical thinking (L. Elders and R. Paul 2003). According to Dwyer, Hogan and Stewart, students' CT also improves when maps are provided and constructed with organized reasoning (C. P. Dwyer, M. J. Hogan, and I. Stewart 2014). According to Ennis, normal, infusion, immersion and mixed whistle are the four primary modalities of teaching. These modalities demonstrate how clear the teacher is when blowing the whistle; choosing the appropriate technology is a significant choice that must be made. must be made (R. H. Ennis 2009, N. Garg, A. K. Jain, A. Ansari, A. Sharma, J. Singh, and T. Chugh 2012).

One of the most difficult tasks for teachers is determining how to assess students' CT levels, as there is little consensus on how to do so. The development of a CT assessment system requires a range of subject matter and careful collaboration of university psychometrics experts. Each has a specific responsibility to ensure that assessment techniques are valid, reliable and align with fundamental undergraduate education ideals. Dwyer, Hogan and Stewart supported this, demonstrating that there is a correlation between how CT is taught and how it is classified is unclear (C. P. Dwyer, M. J. Hogan, and I. Stewart 2014, M. K. Khan, A. Haroon, S. A. Hanif, and M. Husain 2012).

Specific pedagogical strategies that encourage their acquisition and educational interventions to improve CT abilities can be used to build up this collection of cognitive skills and CT disposition, reasoned debate, and so on, but they still need to be developed further Less attention has been paid to interventions that promote CT temperament, partly because of the difficulty in dealing with underlying factors such as student motivation, personality, etc. Cruz, Payne-Carrera, & Dominguez identified a strong need for methodology that demonstrates how these temperaments can be encouraged and supported by engineering students can be developed more systematically and continuously (G. Cruz, R. Payan-Carreira, and C. Dominguez 2017). Aimed at scholars to involve in CT knowledge activities, instructional techniques are important. Instructors should be aware of this. Figure 1 shows the different department of the critical thinking (P. Gupta and A. Kumar 2012).

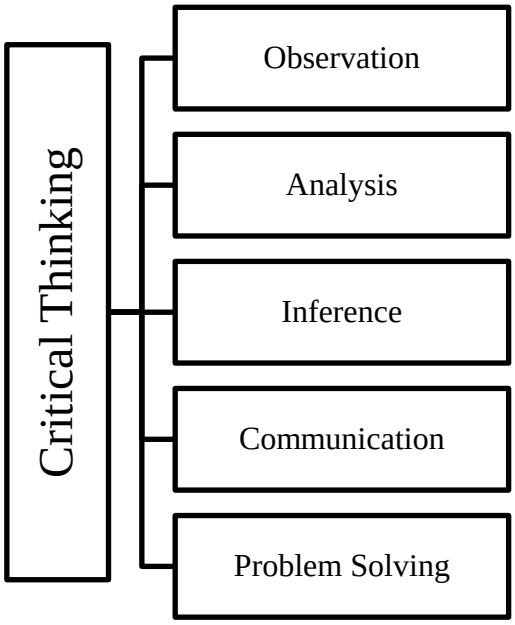

Figure 1. Illustrating the Various Critical Thinking Skills Department

2. Literature Review

Douglas in his study suggested that the Critical thinking is widely accepted as a valuable talent and a fundamental objective of higher education. On the other hand, critical thinking in engineering is surprisingly underrepresented in the literature. Two pilot investigations are described by the authors. On a common critical thinking instrument, graduate engineering students performed less well than undergraduate engineering students, according to mixed-methods study. The familiarity of the two groups taking the test explains this discrepancy. Engineering students were asked how they employ critical thinking in qualitative research. Their description was found to be extra multifaceted than the traditional meanings in the study. General, the findings suggested that further information is needed on what constitutes critical thinking for engineers (E. P. Douglas 2012).

Osman. in their study suggested that all areas of engineering are built on the foundation of design. Authors conducted study toward how civil engineers use critical thinking then quantitative reasoning to solve technical problems. However, there is a lack of evidence in the study on the interaction in applied engineering practice, there is a conflict between these two modes of thinking. Their study described the direct knowledge of building a realistic theory that combines both rational reflection and quantitative thinking in the civil designing process. Authors used a modified fundamentals technique to conduct qualitative research. The data was derived almost entirely from interviews with a developing professional from several engineering consulting organizations. Adhering to specifications, estimating, drawing useful The engineering design process involves arriving at conclusions in six fundamental steps for explaining alternatives, may serve as a reminder to aspiring civil engineers of the need for reflective exercise and logical equations in making and defending choices throughout the engineering design process (S. Osman 2019).

Kobzeva in his study suggested that critical thinking is undeniably indispensable for today's well-educated and innovative engineers. In today's engineering teaching, it is important to teach students how to think, produce and evaluate ideas in a more creative way. The drive of this education was to look at how the Scrabble board game can help engineering students build critical thinking abilities. The study provided an investigation into some of the theoretical sources, observations and education knowledges of board game crossword implementation as a tool to grow critical thinking abilities in engineering scholars. Findings and Conclusions by authors explained how to use the board game Scrabble to improve thinking ability when teaching the EFL (English Football League) (N. Kobzeva 2015).

On reviewing various studies, it was found that the topic is multifaceted; there are several definitions, but the basic notion is that it entails a rational, sceptical, and unbiased inquiry or evaluation of verifiable data. Our study will provide a proper definition and will help the reader to efficiently understand the benefits and importance of critical thinking in one’s life to solve daily routine-based problems.

3. Discussion

The capacity to stay analytical while making connections between concepts is referred to as critical thinking. To tackle real-life situations, critical thinking abilities are essential. It was espoused by some of the oldest philosophers, including Socrates, Chanakya, and Plato, and has been the topic of considerable discussion. Sir Francis Bacon, a seventeenth-century English philosopher and politician, was worried about how we abuse our brains in the search of knowledge. He realized that our brains are infamous things that should not be allowed to follow their natural inclinations.

In today's society, we live in an information-rich environment, and since we humans multitask, information processing issues develop. We recognize the significance of critical thinking in the decision-making process. This not only helps engineering graduates make the best choice, but it also helps them grow as responsible and evaluative individuals. Critical thinking is the capacity to stay analytical while linking disparate concepts to produce meaningful outcomes. Critical thinking should be ingrained in an engineer's mental faculties since it complements the other skills required for the job and is a key aspect in achieving remarkable results (B. K. Singh, A. K. Singh, and V. K. Singh 2018, P. Choudhary, R. K. Dwivedi, and Umang 2019).

One of the fundamental goals of higher education has always been to in still the habit of critical thinking in scholars, in instruction to prepare them to be responsible, evaluative individuals. Engineers themselves seem to have gone deep down the rabbit hole of technical knowledge in India, where engineering appears to be one of the most sought-after professions for job stability and salary. They sat in front of their computer screens, coding their way through life with blinkers on, turning out every ounce of critical pondering. As a result, critical thinking is a rationalization procedure that entails (B. Shandy Narmaditya, D. Wulandari, and S. R. Binti Sakarji 2018, N. ZarifSanaiey, M. Amini, and F. Saadat 2014, Tahrir, F. S. Nurdin, and I. R. Damayanti 2020, T. Pieterse, H. Lawrence, and H. Friedrich-Nel 2016) :

- Self-directed
- Self-disciplined
- Self-monitored
- Self-corrective

The development of critical thinking skills is crucial for engineering graduates and aspiring engineers since it allows them to achieve (Figure 2):

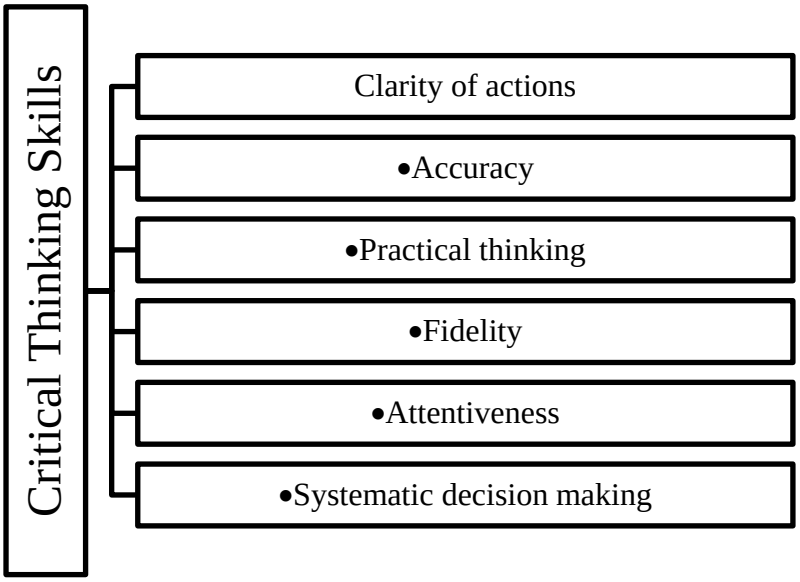

Figure 2. Illustrating the Crucial Critical Thinking Skills for Engineering Students

According to studies, engineers who use critical thinking abilities perform better on both a personal and professional level. Specific disciplines of engineering need such abilities from students (Figure 3):

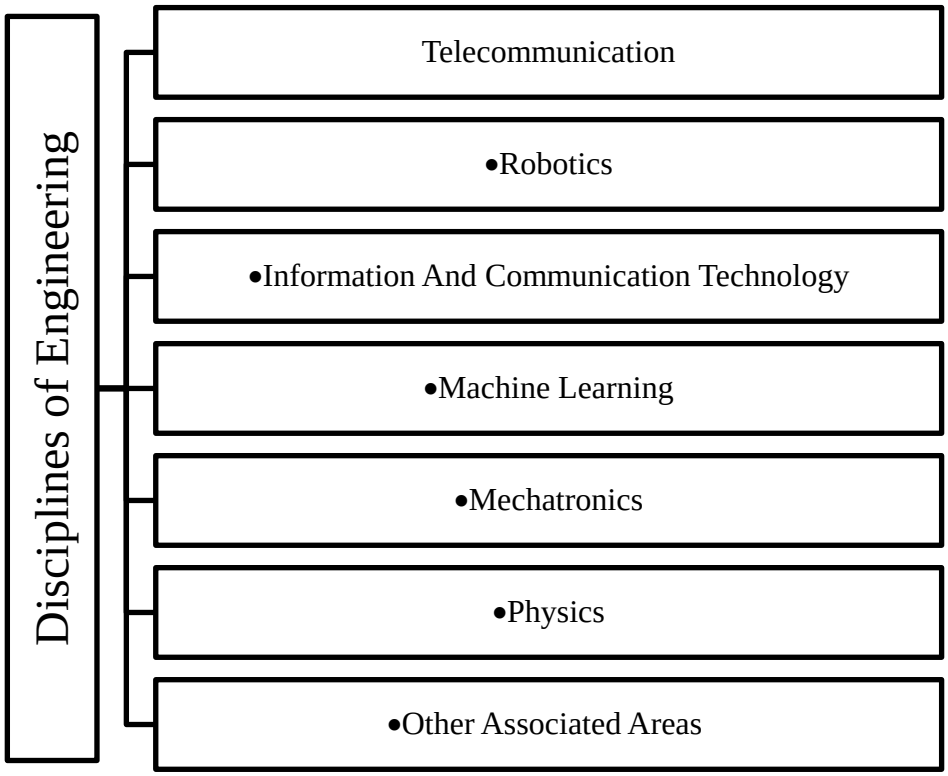

Figure 3. Illustrating the Specific Disciplines of Engineering for Students

Engineers who exercise critical thinking do considerably better in both their professional and personal lives, according to studies. At Arya College of Engineering, we stress the importance of students learning and practicing critical thinking abilities. This will enable them to convert data into actionable information that can be readily comprehended to achieve the desired results. Furthermore, critical thinking abilities will increase over time since learning is a continual and lifelong process (T. Agrawal, A. K. Agrawal, and S. K. Singh 2019).

Future engineers with such extraordinary abilities will have a competitive advantage over their colleagues and peers on both a professional and personal level. Furthermore, critical thinking abilities cannot be acquired or mastered overnight, since it is the job of advanced teaching organisations to offer the ideal atmosphere for students to grow and incorporate such talents (K. K. Gola, M. Dhingra, and R. Rathore2019).

3.1 Mental Process

To acquire intellectual qualities, critical thinkers regularly apply intelligent values to portions of logic.

- Engineering student's criteria should be used (clarity, accuracy, relevance, logic, accuracy and breadth).
- According to our results, engineering students are less aware of the intellectual traits of humility, autonomy, integrity, empathy, and above all, objectivity, making them more difficult to accomplish.

Elements are mental elements that may be utilized to deconstruct any critical thinking into its component parts. Components are evaluated using criteria, while attributes are used to characterize the qualities of a competent critical thinker (C. Cone, D. Godwin, K. Salazar, R. Bond, M. Thompson, and O. Myers 2016).

As our study shows, some of The following are some of the strategies that have been shown to be successful in teaching critical thinking to engineering scholars: flexible problems and discussions, including case studies, paradigms, dilemmas, discussions, and reflection; writing for reflection; recognize interdisciplinary problems involving community aspects, fine arts, music and even moderate exercise; open-ended problems and discussions, including case studies, paradigms, dilemmas, discussions and reflections; as well as active (as opposed to passive) learning. Figure 4 shows the learning methods that suppress critical thinking.

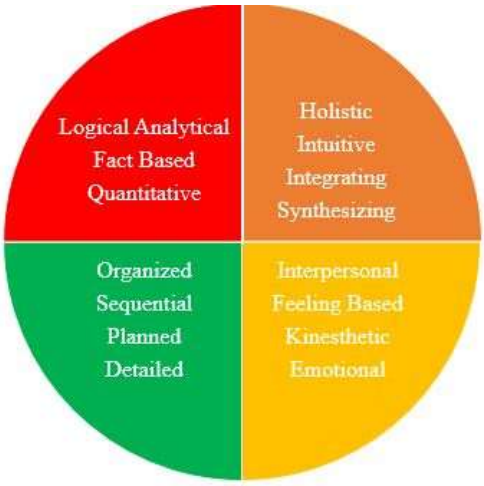

Figure 4. Illustrating the Learning Methods That Suppress Critical Thinking

4. Conclusion

Students learn how to describe and evaluate issues while overcoming fallacies and false beliefs via critical thinking. They learn to construct powerful, powerful case based on facts and reason. They're also skilled at seeing flaws, gaps, and unfounded assumptions in other people's arguments. Companies, particularly in engineering, are seeing a decline in graduates' CT ability, which has resulted in CT tests being used in engineering education. Many engineering employers tend to believe that degree holders lack CT abilities. There is a need for a more organized approach to CT in engineering curricula, where competences are learnt throughout the curriculum and connections and parallels are formed in ideas and stages. Although the authors have uncovered a number of interesting and valuable reasons to support CT, their impact on student skills seems to be limited, thus they aren't part of a bigger coordinated approach for teaching CT and ensuring that CT is a high priority in educational programs. It's also worth noting that among examiners, no one agrees on how CT should be assessed. This view is echoed in recent study on new engineering approaches courses. The study's main worry is that pupils' CT skills are mostly reliant on individual or group efforts (teachers). Well-funded research projects that allow numerous approaches to be produced and evaluated over a long period of time in higher education engineering programs are required to guarantee that CT is clearly incorporated into university curriculum.

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