Journal of Engineering Education Transformations ,
Volume 31 , No. 3, January 2018, ISSN 2349-2473, eISSN 2394-1707

Classroom Teaching to Enhance Critical Thinking and Problem-Solving Skills for developing IOT Applications

Syed Abdur Rauf Magrabi[1], Moghal Irfan Pasha[2], Moghal Yaseen Pasha[3]
[1]Department of Electrical and Electronics Engineering, Sphoorthy Engineering College, Nadergul, Hyderabad.501510.
[2,3]Department of Computer Science Engineering, Sphoorthy Engineering College, Nadergul, Hyderabad.501510.
[1]syedabdurraufmagrabi@sphoorthyengg.ac.in
[2]mirfanpasha@sphoorthyengg.ac.in
[3]myaseenpasha@sphoorthyengg.ac.in

Abstract:Critical thinking is a learned skill that requires instruction and continuous practice. Engineering education instructor's levels can enhance students' critical thinking skills by using instructional strategies that actively engage students in the learning process rather than relying on lecture and rote memorization, focusing instruction on the process of learning rather than solely on the content on theory of Internet Of Things (IOT), and using assessment techniques that provide students to develop a prototype with an intellectual challenge rather than memory recall. Several barriers can impede critical thinking instruction. Lack of training, limited resources, biased preconceptions, and time constraints conspire to negate learning environments that promote critical thinking. However, actively engaging students in project-based or collaborative activities can encourage students' critical thinking development if instructors model the thinking process, use effective questioning techniques, and guide students' critical thinking processes. The examples provided challenge instructors to think of students as users of information rather than receivers of information. Results and evidences are shown where the students and faculty have engaged in a collaborative work for building an IOT device for various applications.

Syed Abdur Rauf Magrabi
Department of Electrical and Electronics Engineering,
Sphoorthy Engineering College, Nadergul, Hyderabad. 501510.
syedabdurraufmagrabi@sphoorthyengg.ac.in

Keywords: Critical thinking, Engineering education, IOT, design projects etc.

1. Introduction

Critical thinking skills are important because they enable students to deal effectively with social, scientific, and practical problems. Critical thinking students who are able to think critically are able to solve problems effectively. Merely having knowledge or information is not enough the most important part is to design an innovative project which can inculcate the process of learning and to be effective in the workplace (and in their personal lives), students must be able to solve problems to make effective decisions which they must be able to think critically in designing or developing a project on IOT[Synder et al., 2008]&[Foshay et al., 2003].

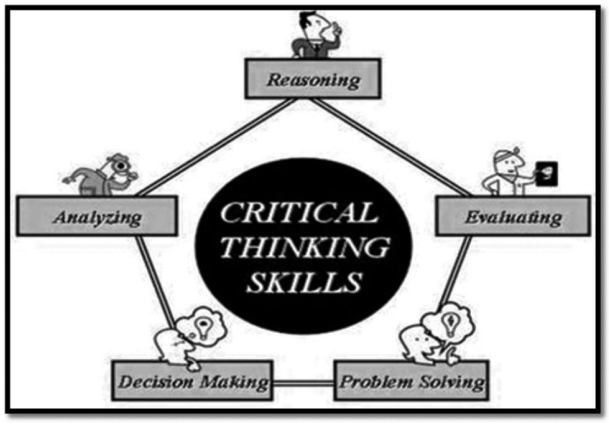

Figure 1: shows the sequence of critical thinking

In the above figure 1, it clearly describes about the behaviour where students and faculty must poses to solve problem critically the first thing is reasoning, evaluating the data or any analytics, problem solving skills, decision making and analysing this process can be done as individual work or a collaborative work/group work. The below table 1 shows the relationship between critical thinking attributes, teaching/learning activities and challenges for critical thinking

Critical Thinking Attributes	Teaching/Learning Activities	Challenges for Critical Thinking
Look for multiple answers, elucidations, opinions, options, solutions	Use multiple case studies, programs, examples that illustrate variation, comparison and connection	Examine students to generate m ultiple opinions, views, solutions, investigation in projects/assignments
Evaluate assess concept, planning, methodology, solutions	Taking risk (by implementing various strategies to design an IOT project)	Give feedback (every day, every week) but the process to be continuous to make the students gets satisfaction of what they are doing
Independent and creative thinking	Inductive teaching rather than deductive teaching	Provide students with necessary information and data or material for which they can identify the problem and give various solutions

2. Strategies to Think Critically

There are various strategies to think critically and most of this work may or may not be only individual role but can be seen in group course work/ project work in collaborative manner.

- Continuous discussion between faculty and students
- Analyzing the problems through case studies and providing necessary solutions
- Reading lecture material and referring to research articles from reputed journals
- Use of software's to trace and track problems wherever encountered in designing and building files
- Summarizing the concepts gathered from the date of project given
- Identifying the types of components to be used and to list the working principles of those components
- Asking question between different groups and teams members
- Resources/materials/data sheets to be used for the products
- Enumerate the possible aspects of outputs and results
- Instructors need to show some involvement when the students get stuck completely and making them to understand the situation and showing ways to rectify the problems in their projects for real time applications.
- Online/offline mode of discussion between students-student's interaction, faculty-student interaction etc.
- Self-correctness for identify, analyzing and summarizing between theoretical and practical concepts.
- Should poses the caliber to manage time using GNATT chart, PERT-1 chart, and PERT-2 chart or must take advice from guide or supervisor for time management between regular classes and project works (mini and major project).

3. How to ask the right questions

Asking the Right Questions: Critical thinking is best supported when instructors use critical questioning techniques and demonstrating the live projects on IOT to engage students actively in the learning process.

Sample questions from all these studies include the following:

- What do you think about this?
- Why do you think that?
- What is your knowledge based upon?
- What does it imply and presuppose?
- What explains it, connects to it, leads from it?

- How are you viewing it?
- Should it be viewed differently?

These questions require students to evaluate the clarity and accuracy of their thinking as well as the depth and breadth of their thinking. Have they considered all the alternatives? Do they know why they think the way they do? Students need to determine whether the content they are using is relevant and if their thinking process is logical. By questioning their thought process, students can begin thinking about their thinking. Research on questioning methodology also suggests that instructors should wait for student responses too often the students' silence is filled by the instructor re-wording the question or asking a different student for a response. However, most students need at least 8 to 12 seconds to process and formulate their response, especially in critical thinking situations. If a question is based on rote memory recall, speed may be relevant; however, thinking requires time and patience. Give students the time they need to think critically. [Yearworth et al., 2013]

The 21st century skills include

- Personal and social responsibility
- Planning, critical thinking, reasoning, and creativity
- Strong communication skills, both for interpersonal and presentation needs
- Cross-cultural understanding
- Visualizing and decision making
- Knowing how and when to use technology and choosing the most appropriate tool for the task

4. Sequential Process of Critical Thinking

Thinking critically improves the ability of students to think independently and can get the level of confidence to develop their own real-time projects where they can implement hardware and software in classroom and in practical labs. In a competitive world critical thinking allows engineering students to analyse their projects in real time applications such a manner that will help the society, environment and sustainability.

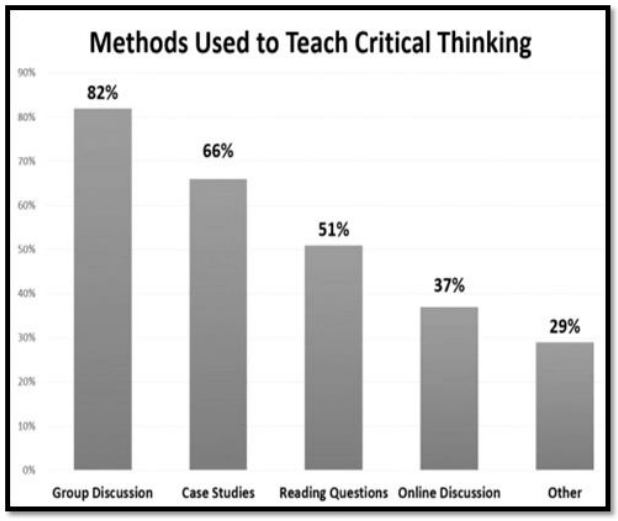

Figure 2: shows the methods used to teach critical thinking.

For more about critical thinking refer [Daniel, 2007] to why it is hard to think critically. Thinking critically is not only for students but faculty too need to develop their own learning styles to think critically it's not just ordering the students to develop but too faculty must pose to think critically, to learn there are several websites where student/faculty can find help if they want to change the focus of any course to make it more thinking skills [Diane, 1999] based. Many of these sites are administered within individual disciplines. In engineering education for electrical components and principles (IOT applications) these websites are best suited as per my knowledge “electrical4you” and “ieeexplore” these websites must be registered by the engineering institutions where students and faculty can get benefit out it and can explore their ideas, thoughts to make any course in engineering par with excellence where finding a problem becomes simple task and analysing different levels to solve that problem. It contains learning activities designed to help students think critically about issues in the respective field of engineering education as mentioned in IEEEXplore journals and electrical4you websites.One recent example from this site provides instruction in the use of analysis and experimental skills; critical thinking skills are applied to course content, with explicit instruction in both the skills and the content. Other teaching materials, including syllabus, course contents, reading page numbers, course materials, lecture-notes, demonstrations, references, books and learning activities.

5. Results and Evidences

For designing an IOT application students worked in collaborative manner for long hours without having any basic background on programming, designing and compiling projects on their own. Whenever the students stuck in any problem faculty involvement plays an important part for finding out the solutions hence the results and evidences for designing projects collaboratively and thinking critically are shown below:

Figure 3: shows the students finding out different ways to rectify problems in project.

Figure 4: shows the collaborative work between students and faculty assisting students to avoid problems.

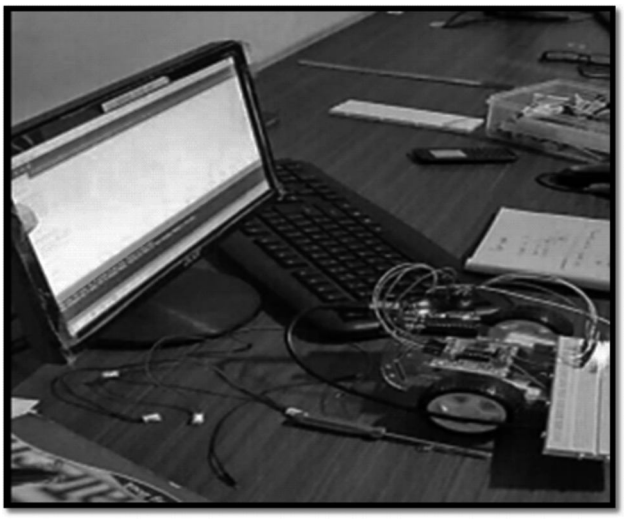

Figure 5: shows the various components tools required for building, designing, analyzing the IOT project [Syed et al., 2017].

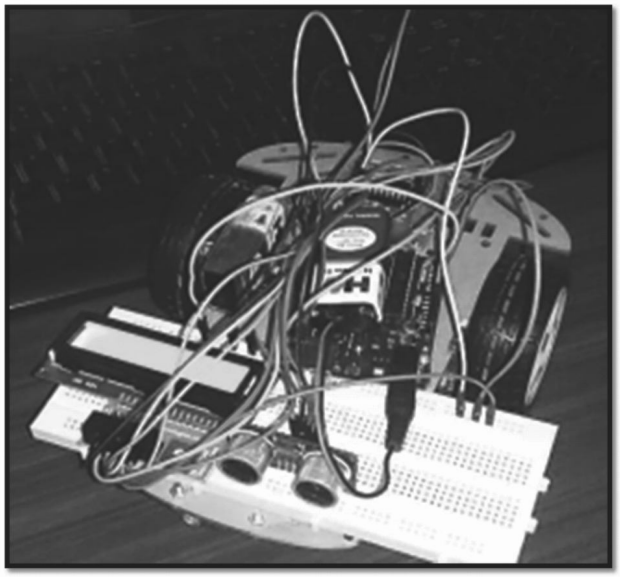

Figure 6: shows the complete work on IOT project on designing an obstacle detection robot using Bluetooth and ultrasonic sensors [Syed et al., 2017].

6. Conclusions

The major goal for engineering educators who want to instil critical thinking skills in their classrooms is to think of their students not as receivers of information, but as users of information. Learning environments that actively engage students in the investigation of information and the application of knowledge will promote students' critical thinking skills. In engineering education any skill, critical thinking requires training, practice, and patience.

Students may initially resist instructional questioning techniques if they previously have been required only to remember information and not think about what they know. They may struggle with assessment questions that are not taken precise from the book. However, by encouraging students throughout the process and modeling thinking behaviors, students' critical thinking skills can improve. The effort is worth the reward students who can critically think for themselves and solve real-world problems [Snyder et al., 2008].

Acknowledgement

We would like to thank Sphoorthy Engineering College Management, Director and Principal for financial support and providing us with IIEECP course for implementing new methodologies of teaching pedagogies and we extend our thanks to IUCEE team for their continuous support and encouragement during the online course

References

[1]. L.G Snyder, M.J Synder (2008) "Teaching Critical Thinking and Problem Solving Skills" The Delta Pi Epsilon Journal, Volune 1 No. 2, Spring/Summer available online "http://reforma.fen.uchile.cl/Papers/Teaching%20Critical%20Thinking%20Skills%20and%20problem%20solving%20skills%20-%20Gueldenzoph,%20Snyder.pdf" [23-July-2017]

[2]. R. Foshay, J. Kirkley (2003) "Principles for Teaching Problem Solving" Plato Learning available from "http://vcell.ndsu.nodak.edu/~ganesh/seminar/2003_Foshay_PLATO%20Learning%20Inc._Tech%20Paper%20%234_Principles%20for%20Teaching%20Problem-Solving.pdf" [25-July-2017]

[3]. M. Yearworth, G. Edwards, J. Davis, K. Burger, A. Terry (2013) "Integrating Problem Solving and Research Methods Teaching for Systems Practice in Engineering" Elsevier, SciVerse Science Direct, Procedia Computer Science available online "http://www.sciencedirect.com/science/article/pii/S1877050913001142" [24-July-2017]

[4]. NC Teacher (2006) "Best Practices: A Resource for Teachers" Public Schools of Noth Carolina, Department of Public Instruction: Elementary Division available online "http://www.ncpublicschools.org/docs/curriculum/bpractices2.pdf" [20-July-2017]

[5]. Edutopia (2017) "Why do we need technology integration?" George Lucas Educational Foundation available online "https://www.edutopia.org/technology-integration-guide-importance" [24-July-2017]

[6]. Diane F. Halpern (1999), "Teaching for Critical Thinking: Helping College Students Develop the Skills and Dispositions of a Critical Thinker" New directions for teaching and learning, page no. 80 [11-July-2017]

[7]. Daniel T. Willingham (2007), "Critical Thinking: Why is it so hard to Teach?" American Educator, Summer 2007 [15-July-2017]

[8]. C.B. MacKnight (2000), "Teaching Critical Thinking through Online Discussions" Educause Quarterly, November 4 2000 [16-July-2017]

[9]. Edutopia (2017) "Training Teachers to Teach Critical Thinking" George Lucas Educational Foundation available online "https://www.edutopia.org/stw-kipp-critical-thinking-professional-development-video[01-Aug-2017]

[10]. Study Guides and Strategies (2011) "Teaching Critical Thinking" An educational public service available online "http://www.studygs.net/teaching/crttch.htm" [01-Aug-2017]

[11]. The University of Tennessee Chattanooga (2017) "Critical Thinking" Walker Center for Teaching and Learning "https://www.utc.edu/walker-center-teaching-learning/teaching-resources/ct-ps.php" [02-Aug-2017]

[12]. Global Digital Citizen Foundation (2017) "12 Strong Strategies for Effective Teaching Critical Thinking Skills" available online "https://globaldigitalcitizen.org/12-strategies-teaching-critical-thinking-skills" [04-Aug-2017]

[13]. Teachthought (2017) "25 of the Best Resources

for Teaching Critical Thinking" available online "http://www.teachthought.com/critical-thinking/25-resources-for-teaching-critical-thinking" [08-Aug-2017]

[14]. Syed Abdur Rauf Magrabi, Sarikonda Meghana (2017). Obstacle Avoidance MOBOT Displaying the Detected Distance and Time by Interfacing Bluetooth with Ultrasonic Sensor Controlled via Smartphone. Journal of Microcontroller Engineering and Applications. 2017;4(2): 25–28p.