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Inculcating Critical Thinking Skills in Language Teaching among the Students of Engineering

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Abstract

In order to assist students, succeed in the corporate world of the twenty-first century, certain effective critical thinking skills (CTS) tactics must be used in the classroom. These strategies should be based on the current engineering design process (EDP) to explore students' CTS. A case study in which students were assigned to an EDP English class was done for the approach. Data was examined at each EDP stage using CTS criteria codes. The results showed that at each EDP step, students have satisfied specific CTS requirements. The pupils received the most important instruction in phonetics, voice, and accent. It was discovered that a special emphasis on recently established methodologies, such as task-based language acquisition and cooperative learning, should be included in order to enable the students thrive in group discussions. The research's findings have thus provided conclusive evidence that the effectiveness of the students' participation in EDP is required for the study of CTS.

Key Terms: Skills in analytical thinking, time management, icebreakers, the design engineering process, and Just a Minute lectures.

Introduction

As an ultimate learning activity (Fuad et al 2020, 101) in this new millennium, building one's ability, "Critical Thinking Skills (CTS)" supports students' decision-making in a specific manner, throughout the learning process. CTS encourages pupils to analyse problems and weigh potential solutions when they are presented with them. In addition to giving students the chance to utilise a justifiable rationale for their thinking, CTS's method involves both the issues and possible solutions. CT remembers coherent smart reasoning for request to foster a judgment in light of the main pressing concern, incorporates an individual's capacity for confounded thinking, issue goal, and metacognition (Ennis 1989, 18). Also in the cognitive realm, CT is rational, reflective thinking that is concentrated on a choice that the students make or believe in (Ennis 1993, 32). Facione (1990), on the other hand, hypothesised that CTS is related to one's capacity for thought and affect. CT, or reflective thinking, is the process of examining, assessing, or synthesising pertinent data to create an argument and reach a judgement (Ennis 1993; Ghanizadeh 2017, 74). In their 2018 proposal, Wechsler et al. suggested that CTS be obliged to assess student behaviour and display exams taken following the CTS procedure.

In a review by Mutakinati 2018, for instance, after an English class, for junior high college students took a CTS post-test. The outcome demonstrated that the students possessed the necessary critical thinking abilities to evaluate their proposed strategies for systematic practise, including developing a plausible assessment of their capacity for thought. Besides, Ahmad et al's review encouraged pupils to concentrate on more by utilizing the strategies and comprehension of how to develop a hypothesis, helping pupils in making explicitly among colleges on their necessities. He gave a comment to the pupils to gauge their CTS.

"Using instructional strategies that enable students confront real-world issues, CTS can be fostered during the learning process" (Guzey et al 2016, 10). The instructor chooses a method of instruction that encourages students to use arguments to investigate their CT and reach conclusions (Ghanizadeh, 2017). The design process is one of the methods used in CTS instruction (EDP). The findings showed how crucial the EDP phases were to students' comprehension of their very own CTS (Sulaeman et al., 2020, 1933; Spector, Ma 2019). Students can define the issue before making a decision thanks to the EDP implementation's several learning stages (Ark, Topc-u 2020; Tank et al 2018).

Few studies have been conducted to examine how EDP phases affect CTS. What's more, most of CTS research has been quantitative and has utilized factual examination (e.g., Kavenuke 2020, 37; Mutakinati et al 2018, 54). The CTS execution is basic in exhibiting how the pupils acted while utilizing their CT (Ennis, 1994). The current research explore CTS of the pupils in EDP program. The risk of excessive subjectivity while analysing CT performance is a challenge in this study; the authors used the peer-reviewed method to lessen this possible worry (Merriam, Tisdell, 2016).

Research Questions:

(1) How could CTS be supported by the EDP?
(2) How do these factors such as describing the issue, providing justification, and coming up with a solution, help a student's CTS inside the English classroom?

Theoretical Foundation

Critical Thinking Skills (CTS)

Dewey's educational theory can be linked to the urgency of CTS. The theory of experiential learning explains how practical learning occurs via inquiry practises (Dewey 1993). Dewey suggested that the experiential cycle is where the essence of an inquiry is established. This cycle begins from the reason of taking care of troubles and the investigation of relevant information to create an unmistakable depiction of the answer for fixing the issue (Garrison et al., 2001). Intelligent reasoning is utilized in this pattern of involvement preparing to create more helpful reactions (Garrison, 157-172). CT is consistent thoughts to settle on a choice in light of a circumstance welcomed on by Ennis (1989). The CT considers an individual's ability for reflection on an issue's proposed arrangement (Ennis, 1993). Both mental and emotional thoughts require the recognizable proof of CTS (Facione 2020). As per Kavenuke et al. (2020), to settle on a cognitive choice and make an interpretation of it into close to affective domain, CTS involves blending, analyzing, and assessing data. CTS is connected to the profound space notwithstanding the cognitive area. With the utilization of thinking, this domain urges students to convey (Antonieta et al., 2005). While introducing their thoughts, pupils have the opportunity to scrutinize the utilization of logical statements in a logical environment (Farmer, 2018). "CTS begins with a clear experience, such as observing a distinction, running into a trouble, or testing others' statement, and similar to communication through correspondence while utilizing higher-order thinking abilities" (Spector, 2019).

To determine a person's CT proficiency, tools have been created using criteria. Ego, perception, analysis, assessment, and inference were some of the CTS criteria that Ernst and Munroe (2004) looked at. Inquiry, reasoning, and self-control are further ways that CT ability is cultivated in detail (Kabir 2002; Spector, Ma 2019). Pupils can involve contention in CT to choose proof to help their choice (Giri, Paily, 2020, 673–690). Additionally, the CT estimation was made utilizing a portion of the ongoing examinations and models. A performance assessment model, an essay test of critical thinking, a multiple-choice test with written rationale, and an open-ended assessment model could all be used to evaluate CT (Ennis, 1993). Commonly, trial research is utilized to give the CTS estimation (Farmer, Wilkinson 2020). The statistical median data for different student levels, including low and high, can then be used to characterise the CTS (Kim et al., 2013, 223). Further research is necessary because there are not enough studies to prove that CT is effective in the learning process.

Applying a teaching strategy that emphasises reflective thinking will enable research

on CT measurement through performance tests (SEN 2020). The instructional strategy demonstrates the learning series, which entails problem definition, the creation of a design solution based on rational argument, and decision-making. The EDP's implementation is one of the teaching strategies that makes the cycle replica easier to use in the English class.

"Engineering is a regulation that employs a body of knowledge applied through mathematical, technological, and scientific means to address issues while abiding by limitations" (NGSS, 2013; NRC, 2012). Iterative problem-solving, being receptive to the idea of several potential solutions, and having a solid grasp of the fusion of scientific, mathematical, and technological concepts are some of the most crucial components of continuous design, a crucial component of engineering (Guzey 2014). The engineering design process is crucial for encouraging cooperation and interpersonal contact (Sulaeman 2020). In order to tackle a problem in the real world, the EDP uses an activity designed by an engineer.

Students recognise engineering practise while working through a challenge in stages using a cycling approach. Students are involved in recognising problems, comprehending technical requirements, and providing many potential solutions during these phases (Lotteroperdue et al 2015, 60).

Through the definition of a problem, the development of an argument, and the identification of a solution, the EDP addresses students' capacity for decision-making (Guzey 2017). As a result, the EDP stage serves as a bridge in this study to enable CTS. Cycling is used to carry out EDP, which starts with problem definition, scientific concept learning, solution design, solution trial and error, and judgement (Tank et al 2018). Additionally, by stating a problem, developing a case, and drawing a conclusion, each EDP stage can help the CTS come up with a solution in the design classroom via the inquiry (Ahern et al 2012, 125). In general, intellectual capital is the outcome of EDP since it creates resources like skills and knowledge that raise the labour force's capacity for production. Some claim that in the past, selecting the best candidate for any multinational company entirely hinged on their technical competence and professional degree. This is not true at the moment, though, as business expectations have drastically shifted. "Students, primarily in developing countries, who have received a few years of professional English teaching, commonly remain deficient in their ability to properly use the dialect, and to fully comprehend its use, in communicating, whether it be in the spoken or written mode." (Widdowson 118). Pupils who have these important soft skills have a considerably higher chance of surviving in the highly competitive corporate world than students who lack them. Among these abilities are effective communication, leadership traits, a problem-solving mindset, logical reasoning, handling interviews, time management, adaptability, decision-making, teamwork, creativity, business etiquette, analytical abilities, etc. The point of the study is to determine the risky trying to think employability that recent graduates need, as well as to assess how value may be produced from side-to-side efficient data managers in aspects of teaching methods, hands-on having to learn, evaluation processes, and suitable feedback systems. According to I. Padmini (90–94), employability skills are the "foundational abilities" on which it is possible to build job-specific competencies, including communication, building relationships with others, problem-solving abilities, and management of business structures. For engineering undergraduates, the following are some examples of soft skills or employability skills that are recommended: group discussions, role plays, situational dialogues, JAM (Just A Minute Session), leadership, analytical, logical, presentation, teamwork, entrepreneurial, and critical reasoning and problem-solving skills, to name only a few.

Research Methodology

"A contextual analysis approach was utilized to look at a student in the EDP class in association with CTS" (Yin, 2018). It was only one various contextual investigation since it was the target to investigate a broad EDP using the rules of nonexclusive CTS in light of Renner and Monroe (2004). This learn was carried out using two alternate ways, both online and offline learning, as

it was done throughout the era (COVID-19) (i.e., blended learning). In order to facilitate both solo and group activities, the authors created an EDP worksheet. There could be a maximum of 15 students in the English classroom due to the laws governing education during the pandemic.

The study was led in an English class in one of Tamil Nadu's designing foundations in a region. The EDP required the students to identify an issue, learn about English ideas and associated topics, create a strategy for a solution, and choose that solution (Tank et al 2018). A worksheet for the EDP was created by the authors. This EDP worksheet serves as a teaching tool for students to comprehend the project's EDP stages (Sulaeman et al 2021). It is essential that the corporate sector be considered a significant stakeholder while creating the EDP worksheet.

The team project dealt with a problem for which the students might develop a solution on the given issue. In the classroom, there were 315 minutes' worth of EDP activities, as shown in Figure 1. To gauge the constancy of the students' CTS improvement, the assignment was completed by students both alone and in groups.

Sample

When the study was conducted, 12 CSE students were participating in the study. They signed up for the EDP effort and offered their assistance in both the digital and offline classrooms. Along with receiving parental consent, they also promised to abide by government rules governing health precautions. The full-time English teacher evaluated the proficiency levels of the pupils in a variety of English-related tasks. In Table 1, the student population's demographics are outlined. As indicated by the level of accomplishment, there are three classifications: high ("a student's prosperity was more prominent than 75"), moderate ("a student's prosperity was more noteworthy than 65 however under 75"), and low ("a student's accomplishment was significantly under 65"). At this college, a passing grade for understanding of English principles was considered to be 75. Every prospective professional must be skilled at effective communication if they want to make a lasting impact on the global movement. "The ability to effectively communicate verbally and visually with coworkers, the employer, customers, and the community is very important and is one of the ideal skills and attributes in the construction of an engineer" (Nguyen 1998, 2).

Data Collection

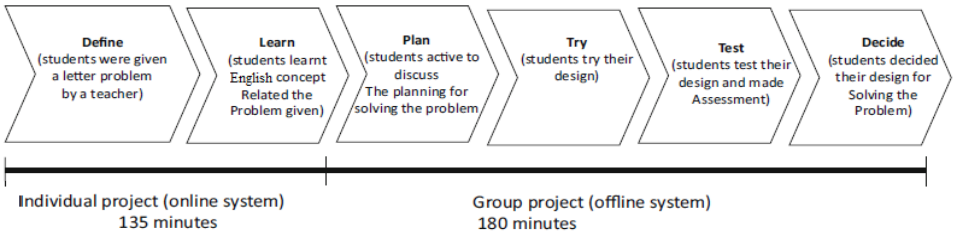

Fig. 1 The EDP steps during implementation in the English classroom

Table 1 Participant demographics

Characteristic	*n*	% of participants
Grade 10	12	100
Gender		
Male	7	59
Female	5	42
Level of English achievement		
High	4	33
Medium	6	50
Low	2	17

Text taken from the EDP worksheet, group discussion recording, and students' interview recording made up the three data sources that were utilised. In the beginning, text was gathered based on the pupils' responses to the EDP worksheet. In order to gather information about students' problem-solving and learning, the EDP worksheet gave pupils assignments to complete on their own. In response to the inquiry, such as "Who has a problem?", students then formed an opinion. What is the issue? Who is the user, precisely? Individual composition from the pupils was assembled in the singular work. The discussion process was also recorded while the students worked in groups. To facilitate analysis, every student interaction was recorded. Planned, tried, and decided stages were the main subjects of the data gathering. Third, in order to obtain the necessary evidence regarding the changes in students' CT abilities, questions were also asked of the students.

Data analysis

The different forms of information be examined using triangulation procedures to ensure the information's accuracy (Creswell, Poth 2016). After determining the EDP stage (see Fig. 1), the authors compared the CT code. Each and every piece of information was typed into text and categorised as shown in Table 2. The criteria specified by Ernst and Munroe were used to build the CT code (2004). Each student's remark at the EDP level was thoroughly read and justified using the CTS standards. Each EDP's total number of CTS criteria was determined and is shown in Table 3. According to the creation of an initiation code at the site, those requirements were split into 2 tiers to symbolise the students' CT talents (Saldana, 2016). As a result, each author classified the information as a peer review (a sample is provided in the Digital Appendix Section) (Merriam, Tisdell, 2016). The authors got together to discuss a consensual student statement when their coding presentations varied.

Findings

Through approaches to the EDP in an English classroom, this study attempted to investigate students' CTS. Our findings go over the appropriateness matrix for each EDP stage and CTS element. The outcomes were also arranged according to how well the students could articulate a problem, support their claims with evidence, and come up with a solution.

The Matrix for EDP Stages and CTS Criteria

The CTS were justified in every step of the EDP based on our examination of the worksheets and student conversations in the English classroom. For the statements made by the students in the EDP project, Table 3 gives code frequency counts.

Students' initial step in the EDP's problem-solving process is to define a solution. The necessary components of the circumstance and the limitations set by the teacher were the focus of the students' problem-solving experiences. Students typically begin the "Define" stage by analysing and recognising a problem that has been assigned to them by the teacher.

Table 3: Coding level of CT

CTS	Level	Example
Interpretation	High	The pupil organised the data and defined the meaning.
	Low	The student failed to express their meaning clearly.
Analysis	High	A design proposal was examined, and the argumentation was recognised and examined.
	Low	Without supporting evidence, claimed a phenomena
Evaluation	High	The allegation was evaluated, and the evidence that would be the basis for the argument was gathered.
	Low	A claim was evaluated without reference to any supporting evidence.
Inference	High	A conclusion was reached after speculating on alternatives and creating several potential fixes.
	Low	Without determining how the variables relate to one another
Explanation	High	Argument presented, method supported
	Low	An argument was made with insufficient support.
Self-regulation	High	Self-correction is the process of analysing oneself with the goal of improving a design.
	Low	Identifying the design's flaws is self-correction.

Criteria for critical thinking skills	Engineering design process stage					
	Define	Learn	Plan	Try	Test	Decide
Analyzing		2	1	1	17	
Interpretation	10	3			3	1
Inference			4		3	1
Self-regulation	1	1			1	14
Explanation	3	13	2	1	5	2
Evaluation		1		8	1	1

Arguments made by students

When they developed, tried, and tested potential practical solutions, the EDP students also presented an argument. During those steps, four students in each group worked collaboratively to discuss a problem they had encountered. In this section, vignettes are used to illustrate the various ways that each group discussed. In this case, the conversation depicts a time when students were attempting to come up with a solution.The potential application of one of the English concepts to construct a report writing was discussed by students [A1], [S1], and [U1]. When the student [U1] joined the discussion part with the group, the degree of CTS increased.

In the EDP, the "decision" stage comes last. In groups, the students worked and contrasted their designs with those of the other groups. The bulk of the CTS in this step was ego. The presenting the outcomes of their final versions to the class to demonstrate how well they could solve the issue. The students also compared their ideas, determining that if one failed, they should redesign it. Comparing the designs of Groups 1 and 2 is shown in Table 4.

Discussion

"The EDP's stages could each be inspected, with most of the CTS noticeable as the fundamental exhibition" (Yu et al 2020, 1001). EDP assumes a risky part in the development of CTS. In addition to developing and meeting the CTS requirements, students who complete the EDP in its entirety also do so. The cognitive domain was described by students using the CTS, particularly while they were working individually; students concentrated on the limitations of a situation, recognised the problem in its context, and emphasised the need that a human being has (Ernst, Monroe 2004, 507–522). The stages of developing a solution, attempting a thought, testing it, and selecting it were all times when students attempted to collaborate in groups to discuss ideas (Giri, Paily 2020; Kabir 2002). Students' use of reasoning to communicate and support their thoughts in this scenario demonstrated the affective domain of the CTS (Antonieta 2005).

The point of the EDP class was to make decisions about commonsense answers for the issue of the rice fields' lack of water. The argumentation process was clearly used by students to reach their decisions as they followed the EDP's processes, from "Plan" to "Test." Students used self-regulation to rethink their answers in this EDP implementation, which incorporated reflective thinking. Student performance that they believe is related to setting a goal must be established again as part of self-regulation (Ghanizadeh 2017). Additionally, when they finished their learning cycle, students switched between considering the problem and the solution (Dewey 1993; Garrison et al 2001). Furthermore, depending on their comprehension of the English principles they had acquired, the students during these tasks created a solution.

Through this technique, it is demonstrated how easily CTS may be improved. Student [U1] demonstrated that his CTS was low while engaging in solo activities, but increased when he joined the group conversation.This example shows how collaborating on a project can enhance a patient's CTS (Farmer and Wilkinson, 2018). Since they offered evidence to back up their statements, the students' communication regarding the solution's design served as an excellent example of argumentation (Mathis et al 2017, 76). As a result, students participated in CTS-required discussion activities and provided evidence for their claims from a number of

sources, including the ones listed above (Yazici et al 2020). According to this study, it is possible to describe the precise CTS requirements for a student during the EDP stages. This study also makes the important contribution of demonstrating the necessity for student performance to be in line with CTS achievement in order to measure CTS.

Generally speaking, using self-regulation and circular thinking to solve the challenges at hand would be preferable. Students get the chance to engage with one another while using the EDP, which helps them come up with better solutions based on English-language standards. Participants were also inspired by this study to reevaluate Developing self-control was the foundation of their communication management methods for the group that displayed CTS. This study distinguishes itself from prior research that looked at the relationship between students' CTS and EDP by providing participants with follow-up CTS exams (Mutakinati 2020). The optimal answer may be found by students using cyclical thinking to take into account the problem and the limitations; this might be further researched (Ark, Topc, 2020; Lottero-Perdue 2018).

Conclusion

This study has uncovered that EDP energizes the CTS of the androgogues and surfed that each period of the EDP affected the pupils' CTS for the study. Pupils were isolated into groups for conversation and examination purposes as a component of the EDP, which advanced pupils' coordinated effort. Preparation, testing, and testing were all followed by students who participated in arguing. After deciding on their solution design, the students conducted a self-examination, comparing the results to those of other groups. In this situation, the use of iterative thinking—one of the goals of successful CTS—was evident.

As indicated by this review, integrating STEM ("Social Science/ Science, Technology, Engineering, and Mathematics") techniques requires designing. Based on this study, it should be recommended to measure CTS while students are studying. The EDP technique might be created by the teacher in the future to teach integrated STEM. To promote students' 21st-century skills, the integration disciplines could be incorporated into the EDP levels in the classroom. Because students demonstrated good behaviour in the CTS, policymakers must encourage the inclusion of EDP in college courses. Administering an EDP in the class also requires offering career development (PD) in the implementation of engineering education. The quality and quantity of EDP applications in STEM education will both increase as a result of this PD. Employability abilities that are based on critical thinking are essential in the current global job market. In order to grow their talent pools, engineering colleges must place a heavy focus on developing critical-thinking abilities in addition to imparting technological knowledge.

Even though this study's sample was small, CTS was nonetheless able to cover the EDP stages in great detail. To consistently convey the results, analysis of the bigger sample size is required. The EDP additionally plans to coordinate design into STEM so that, in later research, the teachers' CTS through STEM erudition can be bust down to congregate pupils' dominance of STEM subjects.

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