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PAPER

Transformative Approach in Engineering Curricula: Enhancing Computational Thinking Through Literacy Skills for Engineering Learners

R. Subhashini(✉)

Department of English, Saveetha Engineering College, Chennai, Tamil Nadu, India

subhashinir@saveetha.ac.in

ABSTRACT

Computational thinking (CT) is a fundamental component of problem-solving and creativity in engineering education. The incorporation of reading comprehension tasks as a method to develop and enhance CT abilities in engineering students is examined in the present study. Students are motivated to analyse, assess, and synthesize knowledge by using text-based resources skills necessary for efficient CT. This method not only improves technical competency but also develops communication and critical thinking skills that are essential for handling challenging engineering problems. This study offers ideas for incorporating reading comprehension into engineering courses, drawing on cognitive theories and educational practices. The goal is to equip students with strong CT skills that are essential in today's technology environment.

KEYWORDS

computational thinking (CT), engineering learners, literacy skills

1 INTRODUCTION

1.1 Integrating computational thinking into literacy skills development for engineering learners

Computational thinking (CT) is an essential component of modern engineering education. CT is typified by problem-solving techniques and algorithmic thinking, and it is the foundation for both technical competence and creativity in engineering fields. Nevertheless, promoting CT abilities in engineering students requires more than just technical expertise; it also calls for an integrated approach that incorporates literacy development [3].

Computational thinking functions are substantially improved by literacy skills, especially those related to textual analysis and reading comprehension. Engineering

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students who interact with technical literature improve their comprehension of the subject matter as well as their capacity to decipher complicated data, draw important conclusions, and use those conclusions wisely in scenarios involving problem-solving. In addition to strengthening the theoretical underpinnings of engineering, this integration fosters critical thinking, logical reasoning, and communication skills qualities necessary for negotiating the complexities of contemporary engineering difficulties [7, 9].

This introductory section lays the groundwork for investigating how engineering education might be improved by utilizing the complementary abilities of CT and literacy. This research tries to clarify methods for incorporating CT into literacy-focused activities in engineering courses by looking at theoretical frameworks and real-world applications [9]. In the end, this all-encompassing strategy aims to provide engineering students with the adaptable skill set required to succeed in a quickly changing technological environment.

The purpose of computational thinking in literacy. For engineering learners, the goal of incorporating CT into the literacy skills development process is diverse and crucial to preparing students for the demands of contemporary engineering practice. This integration accomplishes several important goals:

1. **Strengthening problem-solving capabilities:** Engineering students gain methodical methods of problem-solving by integrating CT into literacy exercises like reading comprehension and textual analysis. They acquire the critical abilities necessary for engineering design and creativity, such as pattern recognition, algorithmic problem solving, and breaking down complicated issues into digestible chunks [4].
2. **Building critical thinking capabilities:** Students who read technical literature must be able to assess material critically, identify trustworthy sources, and formulate well-reasoned judgments. This technique develops a mentality that is essential to engineering research and development by strengthening their capacity for analytical thought and well-informed decision-making [4].
3. **Encouraging effective communication:** Technical concepts and solutions must be communicated effectively to a variety of audiences. Engineering students who work on improving their literacy abilities become more adept at communicating difficult ideas clearly and convincingly, whether in written reports, presentations, or group discussions [5].
4. **Getting ready for technology innovation:** Engineers need to be able to swiftly adjust to new tools and approaches in the ever-evolving technology world of today. By including CT in the development of literacy skills, teachers can make sure that their students are not only adept at using the technologies of today but also capable of picking up new abilities and using them in the future [7].
5. **Implementing demands and standards for education:** The incorporation of CT into literacy skills is consistent with educational standards that prioritize the cross-disciplinary use of technology and critical thinking. It equips students studying engineering to handle the changing needs of academia [5].

To sum up, the goal of incorporating CT into the literacy skills development process for engineering students is to foster the development of a well-rounded skill set that includes technical proficiency along with critical thinking, interdisciplinary awareness, effective communication, and technical innovation readiness. With this all-encompassing approach, students are better prepared to face challenging

engineering problems with creativity and confidence, establishing them as leaders in their industry.

Advantages of integrating computational thinking into literacy skills development for engineering learners. Engineering students may benefit greatly from the integration of CT with literacy skill development. This will enhance their educational experience and position them for future success in the subject. Here are some of the main advantages:

1. **Improved problem-solving capabilities:** Computational thinking – places a strong emphasis on methodical approaches to problem-solving, including abstraction, pattern identification, decomposition, and algorithm building. Engineering students gain a disciplined method for more efficiently understanding and resolving complicated engineering problems by including CT in literacy exercises [4, 9].
2. **Enhanced critical thinking abilities:** Students who read and analyse technical books must be able to critically analyse material, recognize biases, and determine the validity of sources. Their capacity for critical thought and evidence-based decision-making is strengthened via this process, which is beneficial for both academic research and real-world engineering applications [4].
3. **Analytical thinking promotion:** Computational thinking teaches students to approach issues in an algorithmic fashion, which entails dividing them up into manageable chunks and coming up with effective fixes. Students may better apply their reading abilities in the actual world by incorporating CT into their learning process [4, 9].
4. **Facilitation of interdisciplinary connections:** Engineering problems frequently call for cooperation across math, science, and the natural sciences. By incorporating CT into literacy skills, students are better able to identify and take advantage of the links across many disciplines, leading to a more comprehensive grasp of challenging engineering issues and their solutions [10].
5. **Technological literacy development:** By integrating CT, engineering students are guaranteed to be competent not just with existing technologies but also with adjusting to and embracing new ones as they become available. This equips students to manoeuvre and create in the quickly changing technical environment of contemporary engineering [10].
6. **Development of communication skills:** Technical concepts and solutions must be communicated effectively to a variety of audiences. Students who use CT to improve their literacy abilities are better able to express complicated concepts succinctly and effectively [10].
7. **Preparation for professional success:** Candidates with excellent problem-solving, critical thinking, and communication skills in addition to technical competence are highly valued by employers. Engineering students who integrate CT into their literacy skills development will have a more diverse skill set that will increase their employability and position them for leadership roles in their future jobs [10].
8. **Integration with educational standards:** The integration of technology and critical thinking across disciplines is emphasized in several educational standards. By incorporating CT into the development of reading skills, engineering education is guaranteed to achieve these criteria, improving the calibre and applicability of the curriculum [4].

In a nut up, there are certainly numerous advantages to incorporating CT into the literacy skills development of engineering students. These benefits include better problem-solving skills, enhanced critical thinking abilities, encouragement of algorithmic thinking, interdisciplinary connections facilitation, technological literacy development, improved communication skills, readiness for professional success, and alignment with educational standards. Together, these benefits improve the quality of education and position engineering students for success in a field that is changing quickly due to technological advancements [10].

Language Elements in Literacy Skills. For learners in engineering, integrating CT into the development of literacy abilities entails strengthening and improving several essential language components. These components are essential for developing a thorough comprehension of technical material as well as problem-solving techniques. The following linguistic components can be created as a result of this integration:

1. **Technical vocabulary and vocabulary:** Students studying engineering must be conversant in the terminology and specialized vocabulary specific to their subject. The development of literacy abilities through CT requires exposing readers to technical texts that both increase and reinforce their vocabulary. This involves being aware of the words, symbols, and ideas unique to a given domain that are necessary for efficient problem-solving and communication in the engineering field [6].
2. **Reading comprehension techniques:** To extract and comprehend information from technical publications, one must employ effective reading comprehension techniques. Engineering students can learn how to skim for essential concepts, scan for particular details, and combine knowledge from several sources. They can rapidly explore complicated texts and extract insightful information thanks to these tactics [9].
3. **Analytical reasoning and thinking:** Including CT promote analytical reasoning and thinking abilities. Students analyse technical texts critically to appraise claims, appraise supporting data, and make sense of the arguments. This procedure entails finding patterns, drawing links between concepts, and combining data to enhance their comprehension of engineering principles [10].
4. **Systematic problem-solving strategies:** Computational thinking places a strong emphasis on methodical problem-solving strategies such as abstraction, pattern identification, decomposition, and algorithm creation. Engineering students can practice using these methods to examine text-based, real-world engineering challenges through literacy exercises. They get knowledge on how to deconstruct complicated issues into smaller, more manageable pieces, spot underlying trends, and create methodical methods for problem-solving [4].
5. **Effective communication:** Technical ideas and solutions must be communicated effectively to a variety of stakeholders. Engineering students are better able to communicate difficult ideas clearly and convincingly when CT is incorporated into literacy skill development. They get practice in planning their ideas, appropriately writing reports, and giving presentations that convey technical knowledge [10].
6. **Interdisciplinary connections:** Working together across fields like computer science, mathematics, and the natural sciences is frequently necessary to address engineering difficulties. By incorporating CT into the development of reading skills, students are encouraged to identify and take advantage of the links across many subjects [10]. They gain the capacity to incorporate ideas from several

disciplines into their methods of problem-solving, which promotes a more comprehensive comprehension of challenging issues related to engineering.

7. **Information and digital literacy:** In the digital age, engineering students must be proficient in digital literacy, which is the ability to locate, assess, and utilize digital information efficiently. One way to include CT in the development of literacy skills is to educate students on how to do internet research and analyse technical material. Students gain knowledge on how to use digital tools for data analysis and visualization, as well as how to critically assess digital sources and identify reliable information [7].
8. **Metacognitive and reflective thinking:** These two abilities are critical to the advancement of engineering practice and ongoing learning. Through the integration of CT with literacy activities, students can reflect on how they solve problems. They evaluate their tactics, pinpoint areas in need of development, and modify their plans in response to criticism and fresh understanding from their reading and research [4].

Engineering learners obtain a strong skill set that improves their capacity to handle challenging engineering problems by honing these language features through the incorporation of CT into literacy skills development. They develop fluency in the use of language as a tool for comprehension, analysis, and communication of technical ideas, setting them up for success in the fast-paced, multidisciplinary engineering industry [9].

Recent research in computational thinking in literacy skills. The importance of this integration in modern education has been underscored by recent research on the integration of CT with literacy skill development for engineering learners. This integration has produced various novel approaches and outcomes. Key conclusions and patterns from current research are as follows:

1. **Enhanced problem-solving competencies:** Studies have indicated that the use of CT in literacy exercises enhances engineering students' capacity for problem-solving. For instance, research has shown that teaching students to read technical materials and analyse them via a CT lens aids in the development of methodical problem-solving techniques like deconstruction and algorithmic thinking [1].
2. **Analytical thinking and critical reflection:** Research highlights how CT-integrated literacy activities foster the growth of analytical reasoning and critical thinking abilities. Students improve their capacity to critically analyse engineering difficulties and make evidence-based judgments by delving into complicated texts and assessing information [2].
3. **The intersection of disciplines:** Recent investigations highlight how crucial CT-integrated literacy is for promoting interdisciplinarity in engineering education. Through textual analysis, students may investigate links between engineering concepts and other disciplines, such as computer science or mathematics, to develop a comprehensive knowledge that facilitates collaborative problem-solving [3, 8].
4. **Technical literacy and adaptability:** By incorporating CT into literacy development, engineering students are better equipped to navigate a fast-evolving terrain with technical literacy and adaptability. Studies reveal that students learn how to innovate and adjust to new technology developments in addition to becoming proficient in the present technologies [9].

5. **Educational practices and pedagogical approaches:** Several pedagogical strategies for incorporating CT into the development of literacy skills have been investigated in recent research. These consist of case studies, project-based learning, and group projects that encourage students to use CT principles to evaluate and resolve text-based engineering challenges [12].
6. **Teacher professional development:** Research also discusses how to successfully incorporate CT into literacy education through teacher professional development. Research indicates that equipping teachers with the necessary tools and training to carry out CT-integrated activities improves their capacity to assist students' learning and involvement in engineering education [11].
7. **Impacts on student engagement and learning outcomes:** Research suggests that incorporating CT into the instruction of literacy skills enhances learning outcomes and boosts student engagement in engineering education. Through CT-integrated literacy exercises, students report feeling more confident in their ability to solve problems and have a stronger comprehension of engineering principles [13].

In a nutshell, recent investigations highlight the revolutionary effects of incorporating CT into the literacy skill development process for engineering students. This integration equips students to flourish in complex engineering contexts and make valuable contributions to technological innovation and social growth by strengthening their problem-solving skills, critical thinking abilities, interdisciplinary linkages, and technology literacy. To maximize the integration of CT into engineering education, future research will continue to investigate cutting-edge techniques and approaches. This will enhance educational results and equip students for prosperous careers in the field.

2 CONCLUSION

To sum up, which includes CT in the literacy skills development process is an essential strategy for equipping engineering students with the possibilities and problems of the contemporary world. This integration of critical literacy abilities with technical expertise promotes a comprehensive educational experience that gives students substantial advantages.

First off, engineering students' problem-solving skills are improved by incorporating CT concepts into literacy exercises like reading comprehension and textual analysis. They gain knowledge of methodical approaches to complicated engineering problems, such as decomposition, pattern recognition, and algorithmic design skills critical to engineering practice's inventiveness and efficiency.

Second, including CT helps students develop strong analytical reasoning and critical thinking abilities. When reading technical books, students must assess the data, look for trends, and decide.

Additionally, by helping students to see the linkages between engineering concepts and other fields like computer science, mathematics, and the natural sciences, this integration fosters interdisciplinary connections. It makes it possible for them to take ideas from other domains and develop broad knowledge, which is essential when dealing with complex technical problems.

Furthermore, engineering students are better able to express their ideas convincingly and clearly thanks to the development of good communication skills through CT-integrated literacy exercises. Through written reports, presentations,

or group debates, they acquire the ability to coherently and precisely express technical concepts, which improves their capacity for productive teamwork in work environments.

In the end, including CT in the development of reading skills is consistent with educational standards that prioritize the interdisciplinary integration of technology and critical thinking. In addition to preparing students for success in today's technical environments, it also teaches them how to innovate and adapt to new developments in technology.

Finally, this method results in engineering students with a flexible skill set that includes technical expertise, critical literacy, interdisciplinary awareness, and effective communication—a basis that places them in a position to be skilled innovators and problem solvers in the dynamic field of engineering.

2.1 Implications of integrating computational thinking into literacy skills development for engineering learners

The incorporation of CT into the literacy skills development of engineering students has significant consequences for engineering education and the engineering profession. These consequences highlight how this method has a revolutionary effect on learners, teachers, and the larger engineering community:

1. **Increased Academic Results:**
   - Better Problem-Solving Capabilities: Using CT improves students' capacity to tackle challenging engineering challenges methodically. They acquire abilities in deconstruction, pattern identification, and algorithmic thinking all essential for creative and efficient problem-solving.
   - Advancement of Critical Thinking: Students who interact with technical books can assess data, examine claims, and reach conclusions based on supporting evidence. This equips students to respond to a variety of technical difficulties and make well-informed judgments.
   - Integrated Understanding: Students learn links between engineering and related fields like computer science and mathematics by incorporating CT into the development of reading skills. Their comprehension is enhanced and they are more equipped for cooperative, cross-functional working thanks to this interdisciplinary viewpoint.
2. **Preparing for Professional Practice: o Technological Literacy:**
   - Integration of CT guarantees that students are adept at using both established and new technologies, as well as at adjusting to them. They are more equipped to innovate and manage the changing terrain of engineering practice as a result.
   - Effective Communication: Students who receive literacy instruction in addition to CT are better able to explain technical ideas convincingly and concisely. This improves their capacity to work with colleagues, communicate results to stakeholders, and make valuable contributions in work environments.
   - Adaptability and Innovation: Students who possess CT-integrated literacy skills can think flexibly and imaginatively. They gain the ability to use analytical thinking to find answers, modify plans in reaction to criticism, and come up with new ideas in response to shifting technology requirements.
3. **Effect on Engineering Education: Curricular Improvement:**
   - By encouraging a well-balanced combination of technical knowledge and critical thinking, including CT in literacy skills development enhances the

engineering curriculum. Students are better equipped to achieve academic success and satisfy corporate expectations because of this alignment with educational standards.

- Preparation of Teachers: Teachers who implement CT-integrated literacy education improve their pedagogical strategies and broaden their comprehension of interdisciplinary relationships. The curriculum design and instructional strategies are continuously improved with the help of this professional development.

4. **Broad Social Benefits: Innovation and Social Impact:**
   - Graduates of engineering programs who possess CT-integrated literacy abilities are well-positioned to spearhead innovation and successfully tackle global issues. Their capacity to use technological expertise ethically and responsibly benefits society.
   - Diverse and Inclusion: By giving a wide spectrum of students the tools they need to succeed in engineering, CT-integrated literacy development fosters inclusion. It creates an atmosphere in which every student may flourish and progress in engineering theory and practice.

To sum up, integrating the application of CT into the literacy skills development of engineering students not only improves their learning outcomes but also equips them with the necessary tools to address intricate problems, engage in responsible innovation, and make valuable contributions to society. This strategy emphasizes how education has the power to change the course of engineering and advance technical advancement for the good of all.

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4 AUTHOR

Dr. R. Subhashini is an Assistant Professor in the Department of English at Saveetha Engineering College, Chennai, Tamil Nadu, India (E-mail: subhashiniimran@yahoo.com, subhashinir@saveetha.ac.in).