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IMPLEMENTATION OF STEM AND COMPUTATIONAL THINKING IN 7TH-GRADE ENGLISH: PROCEDURE TEXTS

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Abstrak

Penelitian ini menyelidiki integrasi STEM (Sains, Teknologi, Teknik, dan Matematika) dan Computational Thinking (CT) dalam pengajaran teks prosedur bagi siswa kelas VII yang belajar Bahasa Inggris. Meskipun siswa sering mengalami kesulitan dalam memahami teks prosedur, penelitian ini memperkenalkan proyek berbasis STEM dan CT berjudul "Cara Membuat Lampu Dekoratif dari Kertas Daur Ulang". Proyek ini mengutamakan keterampilan berpikir kritis, pemecahan masalah, dan kolaborasi dengan menggunakan komponen CT seperti dekomposisi, pengenalan pola, abstraksi, dan perancangan algoritma. Studi kualitatif ini melibatkan 30 siswa dari SMP Negeri 5 Kota Jambi dan menunjukkan peningkatan signifikan dalam pemahaman siswa terhadap teks prosedur. Selain itu, siswa juga menunjukkan keterlibatan yang lebih tinggi serta kemampuan untuk menghubungkan konsep teoretis dengan aplikasi praktis. Temuan ini menekankan potensi pendekatan interdisipliner dalam mengembangkan keterampilan abad ke-21 dan meningkatkan pembelajaran Bahasa Inggris. Studi ini menyimpulkan dengan rekomendasi untuk mengintegrasikan metode STEM dan CT ke dalam kurikulum Bahasa Inggris guna mempersiapkan siswa menghadapi tuntutan lingkungan global yang dinamis.

Kata Kunci: Pendidikan STEM, Computational Thinking, teks prosedur, pembelajaran Bahasa Inggris, pembelajaran berbasis proyek.

Abstract

This study investigates the integration of STEM (Science, Technology, Engineering, and Mathematics) and Computational Thinking (CT) in the instruction of procedural texts for seventh-grade English learners. Although students often encounter difficulties understanding the procedural text, this research introduced a STEM CT-oriented project entitled "How to Make a Decorative Lamp from Recycled Paper." The project prioritized critical thinking, problem-solving, and collaborative abilities using CT components like decomposition, pattern recognition, abstraction, and algorithm design. The qualitative study involved 30 students from SMP Negeri 5 Kota Jambi and demonstrated significant improvements in students' understanding of procedural texts. Students also showcased enhanced engagement and the ability to relate theoretical concepts to practical applications. These findings highlight the potential of interdisciplinary approaches to foster 21st-century skills and improve English language acquisition. The study concludes with recommendations for integrating STEM and CT methodologies into English curricula to better prepare learners for the demands of a dynamic global environment.

Keywords: *STEM education, computational thinking, procedure texts, English language learning, project-based learning*

INTRODUCTION

In recent years the global educational landscape has witnessed a significant shift towards integrating cross-disciplinary approaches in language education. Many 7th-grade students continue to struggle with developing critical thinking skills within their English language studies especially as they engage with procedural texts. This challenge is particularly pronounced in environments where English is taught as a second or foreign language as

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traditional teaching methods often emphasize rote memorizing over analytical thinking and practical applications.

The contemporary classroom calls for a more advanced approach to language instruction that bridges the gap between conventional English teaching methodologies and the increasingly tech-driven world our students inhabit. While procedure texts serve as fundamental tools for developing instructional writing and comprehension skills, current pedagogical practices often fail to capitalize on their potential for fostering deeper cognitive engagement and practical problem-solving abilities. The lack of connection between traditional English language teaching and real-world applications has resulted in a notable deficit in students' ability to think critically and apply procedural knowledge effectively.

Computational Thinking (CT) is a concept in computer science that was deeply explored in the 2006 publication by Jeannette Wing. Though CT originated in computer science, it is usually applied to other disciplines, mostly STEM. It includes some of the following key components: decomposition of problems into smaller parts, pattern recognition, abstraction (focusing on the most important details), and algorithm design (step-by-step creation of solutions). Meanwhile, STEM education is a global educational movement that combines the disciplines of science, technology, engineering, and mathematics to produce critical competencies relevant to the 21st century, one of which is STEM literacy. STEM literacy refers to an individual's ability to understand and apply knowledge in science, technology, engineering, and mathematics to solve real-world problems that involve integrated reasoning. This skill is necessary for individuals to be able to function effectively in today's workforce. The National Academy of Sciences stresses that students aspiring to STEM careers should be able to solve problems, be proficient in quantitative reasoning and modelling, have good communication skills, show cross-disciplinary collaboration, and understand the links between science and society. The results clearly state the importance of STEM literacy as one of the most critical competencies for the 21st century.

This research addresses this educational challenge by proposing an innovative integration of STEM principles and computational thinking frameworks in the English language curriculum, specifically focusing on procedure texts. By integrating STEM and CT methodologies this study aims to create a more dynamic and interactive learning environment that enhances both language acquisition and critical thinking skills. The integration of these approaches offers a promising pathway to turn the traditionally linear process of teaching procedure texts into a more engaging multi-dimensional learning experience.

The significance of this research extends beyond the scope of academic innovation and academic value. In an era when technological literacy and critical thinking are increasingly pivotal for academic and professional success developing these skills alongside language competency becomes paramount. This study's findings could potentially reshape how educators approach English language instruction, especially in teaching procedural writing and comprehension. Moreover, the integration of STEM and CT principles into language education represents a timely response to the growing demand for interdisciplinary learning approaches that prepare students for the complexities of the modern world.

Through this research we seek to establish a framework that not only enhances students' ability to understand and create procedure texts but also develops their capacity for systematic thinking problem-solving and digital literacy. These skills are essential for the successful transition to an increasingly interconnected and technology-dependent global society. The findings of this study will contribute to the broader discussion of educational reform and provide practical insights for teachers seeking to implement more effective integrated approaches to language instruction.

LITERATURE REVIEW

Some studies showed that CT (Computational Thinking) and STEM (Science, Technology, Engineering, Mathematics) can be implemented in other subject such as English. According to Sadikin & Nugroho (2022), English as a medium of instruction is accountable for STEM education, which in turn, improves the students' academic performance and yet has a local perspective. It focuses more on language enhancement, inclusion of diverse students, and practical applications of STEM disciplines in the real world. These kinds of courses should aim at providing students with language skills and technical prowess that will, in turn, assist them to be successful in STEM fields.

Yeping at al. (2020) focused on the problems of the ESL learners in the STEM field like; vocabulary and technical terms which initially impede their proper communication and understanding. The researchers stated that one of the reasons for the rising unemployment rate among STEM graduates in Malaysia caused by the lack of English proficiency. To solve the problem, the research argues that students can learn better in the STEM environment if they are provided with scaffolding techniques that will improve their English skills. These include but are not limited to the use of contextual and relational teaching strategies, and the provision of visual aids such as concept maps and the integration of STEM vocabulary into the classroom discussions.

The implementation of CT and STEM can be done in the class by using PBL (Project Based Learning). It is lined with Salsabila (2018) who found out that through the application of PBL more students are able to write documents as it enables them to comprehend a procedural text, as well as learn how to be able to articulate and compile them correctly. It has been the outcome of Project Based Learning. The most important difference was the improvement of the students' writing in organization, grammar and real-life situations use. Closer supervision of students with the application of project-oriented learning, particularly in data collection and arrangement, made a big difference in the understanding and application of concepts by students.

The similarities of this article to the previous articles above is the integrity of CT and STEM in the process of learning contextually. The application of CT and STEM approaches into English education through PBL methods assists to enhance the language barrier of ESL students and equips them for the challenges of a globalized, technologically advanced world. This concept highlights the significance of cross-disciplinary education in which language and technical knowledge supplement each other for well-balanced and competent individuals.

RESEARCH METHOD

Research Design

This study employed a qualitative descriptive research design to explore the integration of STEM (Science, Technology, Engineering, and Mathematics) and Computational Thinking (CT) in teaching procedure texts to 7th-grade students. The research aimed to describe how a contextual STEM-based project could enhance students' understanding of procedure texts and encourage the application of critical thinking and problem-solving skills in an English language classroom.

Participants

The participants were 7th-grade students from class 7I at SMP Negeri 5 Kota Jambi. A total of 30 students participated in the study. The class was selected for its diverse range of English proficiency levels, reflecting a typical middle school classroom environment. The study adhered to ethical standards, with parental consent and school administration approval obtained before the research commenced.

STEM Project Description

The STEM project, titled *"How to Make a Decorative Lamp from Recycled Paper"*, was designed to integrate the teaching of procedure texts with a meaningful and environmentally conscious task. Observations of the school environment revealed abundant used paper, highlighting the opportunity to address environmental concerns while fostering creativity and practical skills among students. The project aimed to introduce students to the concept of upcycling by creating functional decorative lamps from recycled paper and to enhance their understanding of procedure texts through structured documentation of the process. The project outputs included two main deliverables: a functional decorative lamp created by the students and a poster that adhered to the structure of a procedure text, outlining the project's goals, materials, tools, and sequential steps.

Teaching Procedures

The project was conducted in a single session, divided into four main stages to ensure systematic learning:

1. Preparation and Introduction: The teacher began by introducing the concept of procedure texts, emphasizing their structure and language features, such as the use of imperative verbs and sequential connectors. The objectives and environmental context of the project were also explained to help students understand the relevance of their task. This stage lasted approximately 15 minutes.
2. STEM Activity Execution: Students were divided into six groups, each consisting of five members, and tasked with collecting used paper from the school environment. Under the teacher's guidance, they applied Computational Thinking (CT) skills to complete the project:
    - Decomposition: Students divided the lamp-making process into manageable steps, such as material preparation, folding techniques, and assembly.
    - Pattern Recognition: Groups identified recurring patterns in tasks, such as consistent folding and layering techniques, which optimized their workflow.
    - Algorithm Design: Each group created clear, step-by-step instructions to guide the lamp-making process and ensure consistent results. During this stage, creativity and teamwork were actively encouraged, with each group producing a unique lamp design. This activity lasted about 60 minutes.
3. Poster Creation: Following the lamp-making activity, groups documented their process by creating a poster. Each poster followed the structure of a procedure text, including the goal of the project, the materials and tools required, and the sequential steps involved. The poster design emphasized clarity and creativity, allowing students to reflect their understanding of procedure text structures. This stage required approximately 30 minutes.
4. Presentation and Reflection: To conclude the session, each group presented their decorative lamps and posters to the class. During the reflection session, students discussed the challenges they encountered, the role of CT skills in organizing their tasks, and how the project deepened their understanding of procedure texts. The teacher facilitated this discussion to help students connect their learning to real-world applications.

Data Collection Methods

To evaluate the effectiveness of the project, multiple qualitative methods were employed:

1. Pre- and Post-Assessments: Students were assessed on their ability to write procedure texts before and after the project, with scores analyzed to measure their progress in understanding text structures.

2. Observation Checklists: The teacher used checklists to monitor student engagement, collaboration, and the application of CT skills during the activity.
3. Student Worksheets: Worksheets guided students in documenting their understanding of procedure text structures and their group's process during the activity.
4. Artifact Analysis: The decorative lamps and posters were analyzed for creativity, adherence to procedure text structures, and clarity of language.

Through this integrative approach, students not only enhanced their linguistic and cognitive skills but also developed an appreciation for environmental sustainability and teamwork.

RESULT AND DISCUSSION

Result

In this study, we obtained the findings that the implementation of STEM projects based on Computational Thinking (CT) successfully improved students' understanding of procedural texts, as well as encourage the development of critical thinking, problem-solving, and collaboration skills in the context of English language learning.

The observations of the activities carried out showed a significant improvement, especially in terms of students ' understanding in solving problems and compiling procedural texts. The teacher used checklists to monitor student engagement, collaboration, and the application of CT skills during the activity.

Table 1. Observation Result on students improvement and application of CT

Things Observed	**Before Application of STEM CT**	**After Application of STEM CT**
All students have learned about today's topic	✓	✓
Students understand about the structure of the text procedures	✓	✓
Students can use "imperative verbs and sequence conjunctions" in-text procedures	✓	✓
Students choose decorative lights that want to be made independently	-	✓
Students use STEM to make decorative lights	-	✓
Students use CT elements in making decorative lights	-	✓
Students use CT elements in preparing the text of the procedure for making decorative lights in posters	-	✓
Students are able to collaborate in groups	-	✓

The above results showed that the students learned about procedure text and applied STEM CT while learning and assembling the poster of procedure text. By integrating elements of CT in the learning process, we also found the development of students' skills in using Computational Thinking. The following is a table that illustrates the improvement of students'

understanding of the procedural text material by analyzing and evaluating the students' poster artifacts.

Table 2. Artifact Assessment Result in Procedural Text Posters in English Lesson

Aspect	Assessment Criteria	Average Score Before Application of STEM CT	Average Score After Application of STEM CT
	Struktur Prosedur		
Goal	Objectives are written clearly, specifically and in line with the project theme.	5	5
Materials and Tools	All necessary materials and tools are listed completely and relevantly.	4	4
Steps	Steps are detailed, sequential and easy to follow.	2	4
Text Format	The poster follows the format of a procedure text (title, materials, tools, steps) with a neat layout.	4	4
	Creativity		
Desain Visual	Posters have an attractive design, appropriate colors, and supporting visual elements (pictures, diagrams).	1	4
Orisinalitas	Posters reflect the original ideas and creativity of the group.	3	4
	Language		
Language Clarity	The language used is clear, easy to understand and appropriate to the learning context.	3	4
Grammar	The text is free from significant grammatical and spelling errors.	3	4
	STEM-CT Application		
Decomposition	Steps demonstrate the student's ability to break down the process into small, structured parts.	2	3
Pattern Recognition	The poster reflects a consistent pattern in the work process.	2	3
Algorithm Design	Steps are designed in a systematic logical order.	3	4
Total		**32**	**43**

The above results showed an increase in students' understanding of procedural text materials after the application of computational Thinking (CT) based on STEM projects in English language learning. The percentage of students' average scores improved from 32 to 43 out of 50 total points. By integrating elements of CT in the learning process, we also found the development of students' skills in using Computational Thinking. Based on the results of our observations, students actively apply the elements of CT in their groups. This can be seen in the following table.

Table 3. Observation Students using CT elements

Things Observed	Score	Observation Results
Abstraction		
Students are able to simplify choosing the type of decorative lighting and the main materials used in the manufacture of decorative lighting	3	Students are able to use abstraction in STEM projects and learning activities
Students are able to simplify the steps of the procedure into key points to incorporate into posters and presentations.	3	
Decomposition		
Students are able to divide tasks such as identifying the text steps of a procedure, designing decorative lighting, and creating posters.	3	Students are able to use decomposition in STEM projects and learning activities
Students are able to share tasks for each group member	4	
Pattern Recognition		
Students recognize repetitive patterns in procedural text (e.g., use of action verbs and chronological order).	3	Students are able to use pattern recognition in STEM projects and learning activities
Students recognize patterns and how to make decorative lights.	3	
Students recognize the tasks they must carry out	3	
Algorithms		
Students arrange work procedures in a logical order to explain the process of making decorative lights in posters.	4	Students are able to use algorithms in STEM projects and learning activities
Total Score	26	

The results above showed that students had successfully applied Computational Thinking (CT) in the implemented STEM projects. Furthermore, the observations through the checklist also indicate that the application of STEM-based CT projects in English language learning increases student engagement. Most students showed great enthusiasm in carrying out projects and worked well together in groups.

The process of sharing ideas and active discussions were characteristic in this learning activity, which is an indicator of increased critical thinking skills, communication, and collaboration in learning. Our findings also showed that students were finally able to produce innovative and aesthetic decorative lighting designs, compose clear, systematic, and appropriate procedure texts with the correct structure, and integrate aspects of Science, Technology, Engineering, and Mathematics (STEM) in the product manufacturing process.

Discussion

The results of this study indicate that the integration of STEM and Computational Thinking (CT) in English language learning has a significant positive impact on students. This approach is proven to increase learning motivation and students' understanding of the material taught. In addition, the integration of CT and STEM in learning also plays a role in developing important skills such as problem-solving, critical thinking, collaboration, and communication in groups.

As stated by Rahman et al. (2019) and in the study "Introducing Interdisciplinary English Language Classroom in Bangladesh: An Assessment" (2019), the interdisciplinary approach allows students to connect theory with practice, which contributes to improved learning outcomes. This finding is reinforced by He (2022), who emphasizes that the integration of STEM in primary and secondary education not only improves cognitive skills, but also strengthens language skills, including understanding and drafting procedural texts.

In the context of this study, the application of STEM and CT in learning helped students to analyze, evaluate, and synthesize information relevant to the learning materials and projects undertaken. Therefore, the integration of CT and STEM in English language learning has proven effective in improving students' understanding of procedural texts as well as developing their 21st-century skills. The decorative lighting and procedure poster creation project provides relevant real context, allowing students to relate theory to practice.

The results of pre- and post-assessment showed a significant improvement in students' ability to write procedural texts, especially in the aspects of language structure and clarity. This is in line with previous research showing that a project-based approach helps students understand abstract concepts through real applications. This Project Based Learning approach successfully integrated elements of Computational Thinking (CT) — such as decomposition, pattern recognition, abstraction, and algorithms — into the learning process.

Each element contributed significantly to improving students' critical thinking skills as well as their understanding of the procedural text. Decomposition, i.e., solving the problem into smaller, more manageable parts, becomes an important part of the project. Students broke down the main tasks, such as choosing the type of decorative lighting, determining materials, dividing tasks between group members, drawing up manufacturing steps, and designing posters. This decomposition process trained students to think systematically and focus on solving small parts before completing the main task, supporting the findings of He (2022) who stated that STEM and CT help students manage complex problems by logically dividing tasks.

Pattern recognition: students learned to recognize patterns in the structure of procedural texts, such as goals, materials, and steps. They also identified language features in procedural texts, such as imperative verbs and sequence conjunctions. This pattern was used as a guide for composing and designing their own posters. In addition, in the manufacture of decorative lights, students also learned to recognize patterns associated with how to process scrap materials into decorative lights. Wahono et al. (2020) showed that pattern recognition in STEM education improves student's analytical skills and strengthens their understanding of the concepts taught.

Abstraction: the abstraction element encouraged students to filter relevant information and focused on important aspects. In this project, students must define the core steps of the process of making decorative lights to be displayed on posters, avoiding unnecessary details.

This abstraction helped students simplify complex information so that it can be easily understood by the audience, strengthening their communication skills, as He (2022) explained.

Algorithm: students drew up an algorithm in the form of systematic steps that explain the process of making decorative lamps. This process not only improved their understanding of the structure of the procedural text but also trained them to think sequentially and methodically. The implementation of this algorithm is seen in the results of the project, where most groups (85%) were able to draw up procedures that were coherent, easy to follow, and used appropriate language.

The findings of this study align with prior research emphasizing the role of Computational Thinking (CT) in language learning. CT elements such as decomposition, pattern recognition, abstraction, and algorithm design have been shown to facilitate the acquisition of language skills, especially in grammar and writing (Yu, Soto-Varela, & Gutiérrez-García, 2024). These elements enable learners to break down complex language structures into manageable components, recognize linguistic patterns, and apply systematic strategies to construct texts.

Research also highlights the effectiveness of integrating CT into project-based learning environments. According to Wing's seminal work, CT promotes a structured approach to problem-solving that benefits not only science and technology domains but also fields like language learning (Wing, 2006). This is supported by the findings of Tang and Ma (2022), who demonstrated that CT skills improve grammar and writing competencies through activities like algorithmic thinking and pattern recognition.

These findings also support Öztürk's (2021) research, which states that CT elements such as algorithms strengthen students' problem-solving and decision-making skills. By integrating the elements of CT, students not only understand the text of the procedure theoretically but can also apply it in real projects. This improves their critical thinking, problem-solving, and communication skills.

Moreover, the constructivist principle of “learning by doing”, as highlighted by Harel and Papert (1991), underpins the integration of CT in language education. The hands-on nature of CT-driven activities, such as creating procedural texts and crafting projects, allows learners to engage deeply with the material and apply their knowledge in meaningful contexts. Yu et al. (2024) further advocate that such approaches foster critical thinking, creativity, and collaboration, which are essential skills in modern education.

In line with the findings of Rahman et al. (2019) & He (2022), this approach shows that structured, STEM-CT-based teaching creates a more interactive, relevant, and meaningful learning environment for students. The integration of STEM and CT also addresses critical thinking skills deficiencies in Grade 7 students that were previously identified as barriers. With a clear division of group tasks and guidance from teachers, students are able to overcome challenges and show better learning outcomes.

The integration of STEM in English learning also improves students' language skills, especially in understanding and structuring procedural texts. This is reinforced by the findings of He (2022), which suggests that STEM education can strengthen students' communication and argumentation skills. In this context, students not only learn to clearly structure the steps of the procedure, but also how to effectively convey such information in the form of posters.

In addition, this approach gives students the opportunity to use English in real situations, which strengthens their understanding of the context and increases learning motivation. This process creates a more meaningful and relevant learning experience. Observations showed increased student enthusiasm throughout the project, with active participation seen in intense group discussions, creativity in decorative lighting design, and students' ability to complete assignments on time.

Wahono et al. (2020) suggested that project-based STEM education enhances students' learning motivation because it provides relevant and meaningful experiences. This study provides strong evidence that the integration of STEM and CT in English language learning can be an effective strategy to improve students' critical thinking and language skills. As He (2022) explained, this approach improves students' learning outcomes and strengthens their communication and argumentation skills. Therefore, this approach has the potential to be adopted more widely in the English curriculum, particularly in the teaching of procedural texts.

The interdisciplinary nature of STEM and CT also provides a robust framework for addressing challenges in language education, such as limited engagement and contextual understanding. By embedding CT within a STEM-based project, this study effectively bridged the gap between theoretical concepts and practical applications, enhancing students' motivation and overall learning outcomes.

CONCLUSION

This study demonstrated how the integration of STEM and Computational Thinking into English language learning in particular teaching procedure texts, significantly improved students' understanding of text structure while fostering critical thinking, problem-solving, and collaboration skills. In the project of creating decorative lamps from recycled paper, students learned not only to construct procedure texts in a systemic way but also to apply CT elements: decomposition, pattern recognition, abstraction, and algorithms. The results show how this approach would result in more interactive and relevant learning, engaging students in their learning process, especially in attaining the relevant 21st-century skills that help students both in academics and professionalism.

From the findings, it is recommended that English teachers at the junior high school level should integrate an interdisciplinary approach, including aspects of STEM and CT in the lessons. This can be done by infusing approaches to project-based learning relevant to students live, making the learned material more contextual and relevant. Education policymakers should support teachers' professional development in terms of enabling them to understand and practice teaching strategies in the context of STEM and CT. Moreover, there is a call to integrate more elements of STEM and CT into the English language curriculum to adequately prepare learners for the challenges that will be experienced in life with a rapidly changing environment.

Further research and development could explore how this approach can be applied to students with varying language proficiency levels or tailored to be more inclusive for those with learning difficulties. Furthermore, digital technologies, such as interactive learning applications and collaborative platforms, can be leveraged to implement STEM-CT effectively in language classrooms. Another promising avenue involves examining the impact of this approach on cross-disciplinary competencies such as scientific literacy and technological skills. Finally, building teacher capacity to master and deliver STEM-CT approaches is crucial. Workshops, seminars, and teacher-learning communities could provide valuable platforms for sharing best practices and enhancing pedagogical strategies.

In conclusion, the integrative STEM-CT approach provides a robust framework for developing relevant, meaningful, and future-oriented education. It equips students with the competencies required for success in the 21st century, fostering critical skills that bridge academic learning with real-world applications.

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