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ENHANCING CREATIVE THINKING THROUGH COMPUTATIONAL THINKING LEARNING STRATEGIES USING GITHUB IN VOCATIONAL SOFTWARE ENGINEERING EDUCATION FOR 11TH-GRADE STUDENTS AT STATE VOCATIONAL HIGHSCHOOL 1 OF SURABAYA (SMK NEGERI 1 SURABAYA)

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Abstract

This study is a systematic literature review (SLR) on enhancing creative thinking through computational thinking learning strategies using GitHub in vocational Software Engineering (RPL) education for 11th-grade students at SMK Negeri 1 Surabaya. The objective of this article is to collect, analyze, and synthesize findings from previous studies to gain a deeper understanding of the relationship between computational thinking, GitHub, and creative thinking in vocational RPL education. The research method used in this SLR article is library research, with sources obtained from the Scopus (Elsevier) and Emerald Publishing databases. Data analysis from previous studies follows the PRISMA method. The findings indicate that creativity enhancement can be achieved through an effective curriculum. Computational thinking needs to be integrated into the curriculum to equip students with skills aligned with digital technology advancements. GitHub serves as a digital tool that fosters innovation and creativity. The study's implications encourage

schools to integrate computational thinking into the RPL curriculum to equip students with problem-solving skills relevant to digital technology developments.

Keywords: *Creative Thinking Enhancement, Computational Thinking, GitHub, Vocational Software Engineering*

INTRODUCTION

The advancement of digital technology has significantly impacted the field of education (Iddrisu Bariham, 2022). One of the most notable positive effects is the enhancement of students' creative thinking skills (Weng et al., 2022). Students can access various references, inspirations, and new insights that enrich their creative ideas (Savić et al., 2020). Additionally, technology provides various tools and platforms that allow students to experiment with new ideas. They can explore creative concepts through technologies such as design software, programming, artificial intelligence, and virtual reality (Iman et al., 2022).

However, digital technology also has negative effects on students' creative thinking skills. Many students become overly reliant on technology to find answers, which limits their ability to develop creative thinking (Khan et al., 2021). Google or artificial intelligence (AI) search engines provide instant answers without requiring students to engage in deeper creative thinking. This can create distractions that hinder students' focus and creativity (Blut & Wang, 2020). Technology often promotes instant solutions, making students less patient in undergoing the creative process, which requires time and perseverance (Chen et al., 2021).

To mitigate the negative impact of technology on students' creative thinking skills, this study introduces a novel approach by implementing computational thinking (CT) in the vocational Software Engineering (RPL) course for 11th-grade students at SMK Negeri 1 Surabaya. Computational thinking is considered a learning strategy that trains students to think logically, systematically, and structurally in problem-solving. One of the technologies used in computational thinking for RPL learning is GitHub. GitHub is a cloud-based collaborative platform commonly used in software development (AlMarzouq et al., 2020). Through GitHub, students can work in teams, share code, and manage programming projects more effectively (Nguyen & Nadi, 2022).

Several previous studies have discussed the benefits of computational thinking in education. For instance, Iddrisu Bariham (2022) reported that 91% of students in Canada successfully solved social problems through programming. Therefore, a systematic review is necessary to further examine the effectiveness of learning strategies using GitHub in vocational RPL education. This study aims to analyze recent research trends, identify effective teaching methods, and evaluate the impact of computational thinking with GitHub on enhancing students' creative thinking skills in RPL education for 11th-grade students at SMK Negeri 1 Surabaya.

LITERATURE REVIEW

Creative Thinking Skills

Creative thinking skills refer to the ability to use structured and consistent reasoning to analyze information, make decisions, and find solutions (Imjai, 2024). Solutions derived from creative thinking must be logical and capable of addressing complex problems (Soufana, 2023). Creative thinking often employs deductive methods to develop logical and effective solutions for complex issues (Turan, 2019). Thus, fostering creative thinking skills is highly relevant for vocational school students, as logical thinking helps them find solutions and make sound decisions in Software Engineering (RPL) education.

According to Jianpeng F. et al. (2024), two key elements contribute to creative thinking outcomes: (a) Creative thinking skills practiced by vocational students in problem-solving. These students can identify opportunities and design programming solutions in response to environmental changes (Vuorio, 2022). (b) The learning ecosystem in vocational schools, which provides students with opportunities to gain experience through digital technology.

Enhancing students' creative thinking has become a primary focus in education today. The ability to think creatively is crucial for students to develop innovative solutions to the problems they face. Therefore, they must be encouraged to think beyond existing frameworks rather than merely following established thought patterns. Education that fosters creativity can positively impact both academic achievement and everyday life. Hence, efforts to enhance students' creative thinking are essential to help them compete in an increasingly challenging world.

Computational Thinking (CT)

One of the effective learning strategies for enhancing students' creative thinking is computational thinking (CT). This approach teaches students to solve problems systematically and logically. CT-based learning not only trains students in algorithmic thinking but also strengthens their ability to solve problems creatively and efficiently. Through this structured learning strategy, students develop skills in problem analysis, solution design, and verification of results.

Computational Thinking (CT) plays a crucial role in developing students' critical and creative thinking skills (Li et al., 2020). CT involves four main steps: decomposition, pattern recognition, abstraction, and algorithm design (Hutchins et al., 2020). In the context of RPL education, these steps help students break down complex software problems into smaller, more manageable components. By engaging in CT-based problem-solving, students develop systematic, creative, and logical thinking skills, enabling them to design innovative applications and software solutions.

GitHub Platform

GitHub is a web-based platform for managing and storing code using version control through Git (Escamilla et al., 2022). It enables software developers to collaborate, share code, and track changes in programming projects efficiently (Tan et al., 2020). Consequently, GitHub enhances students' creative thinking by fostering teamwork, collaboration, and effective problem-solving. It also encourages them to develop innovative software solutions.

Moreover, GitHub, as a collaborative platform, allows students to share and manage programming code more effectively. This improves their programming skills and better prepares them for the increasingly competitive job market (Wermelinger, 2023).

RESEARCH METHOD

Research Design

This study employs a Systematic Literature Review (SLR) to understand the factors that enhance creative thinking through computational thinking-based learning strategies with GitHub in vocational education for 11th-grade Software Engineering (RPL) students at SMK Negeri 1 Surabaya. The SLR approach is highly valuable in integrating findings from multiple studies relevant to this research topic (Septiandari et al., 2024).

The integration of relevant findings is conducted using the PRISMA method, a structured framework within the Systematic Literature Review (SLR). The PRISMA method provides a methodological framework for searching, evaluating, and synthesizing relevant literature to comprehensively understand the latest research findings (Azmat et al., 2023). Additionally, this study ensures that its objectives are well-defined, literature remains relevant, only high-quality sources are selected, findings are synthesized and analyzed effectively, and discussions are presented in a structured manner.

Data and Literature Search

The first step in this study was determining the aspects to be observed or analyzed based on the research topic. The researcher then conducted a literature review focusing on each relevant aspect separately. The relevant literature was collected from highly reputable and comprehensive databases, such as Scopus (Elsevier) and Emerald Publishing. The collected literature focuses on three main topics:

1. Enhancement of Creative Thinking
2. Computational Thinking Learning
3. GitHub Platform

The selected literature is written in English and sourced from various disciplines, including digital technology, economics, business, management, and social sciences.

Table 1. Search Strings in Scopus and Emerald Publishing

Database	Keywords
Scopus	TITLE-ABS-KEY "enhancement of creative thinking" OR "computational thinking learning" AND "platform GitHub"
Emerald Publishing	(("enhancement of creative thinking" OR "computational thinking learning" AND "platform GitHub"))

Literature Screening Criteria

The researcher applied inclusion and exclusion criteria to filter the literature sources. Inclusion Criteria are (1) literature related to the enhancement of creative thinking, (2) literature discussing computational thinking learning, (3) literature related to GitHub, (4) literature written in English. In other hand, exclusion criteria are (1) literature from books, (2) literature not written in English, (3) literature not accessible, (4) literature not relevant to the research topic. All selected literature underwent a thorough review process by the researcher, including an examination of titles, abstracts, content, and conclusions to ensure relevance and quality.

RESEARCH RESULT

Identification of Literature

The researcher collected articles published from 2020 to March 2025 as relevant literature for analysis. The search results from the Scopus database yielded 253 articles, while the Emerald Publishing database had 17 articles. Thus, the initial total from both databases was 270 articles. After an initial identification process to align with the research focus, the number of relevant articles was reduced to 132 articles.

Next, a screening process was conducted based on four inclusion criteria, resulting in 78 research articles. From this selection, filtering based on titles and abstracts narrowed the number of articles down to 58. In the final stage, articles were selected based on alignment with the research objectives, leading to a final selection of 42 articles. After further analysis, 13 articles were found to be highly relevant to this research.

Table 2. Literature Identification from Scopus and Emerald Publishing Databases

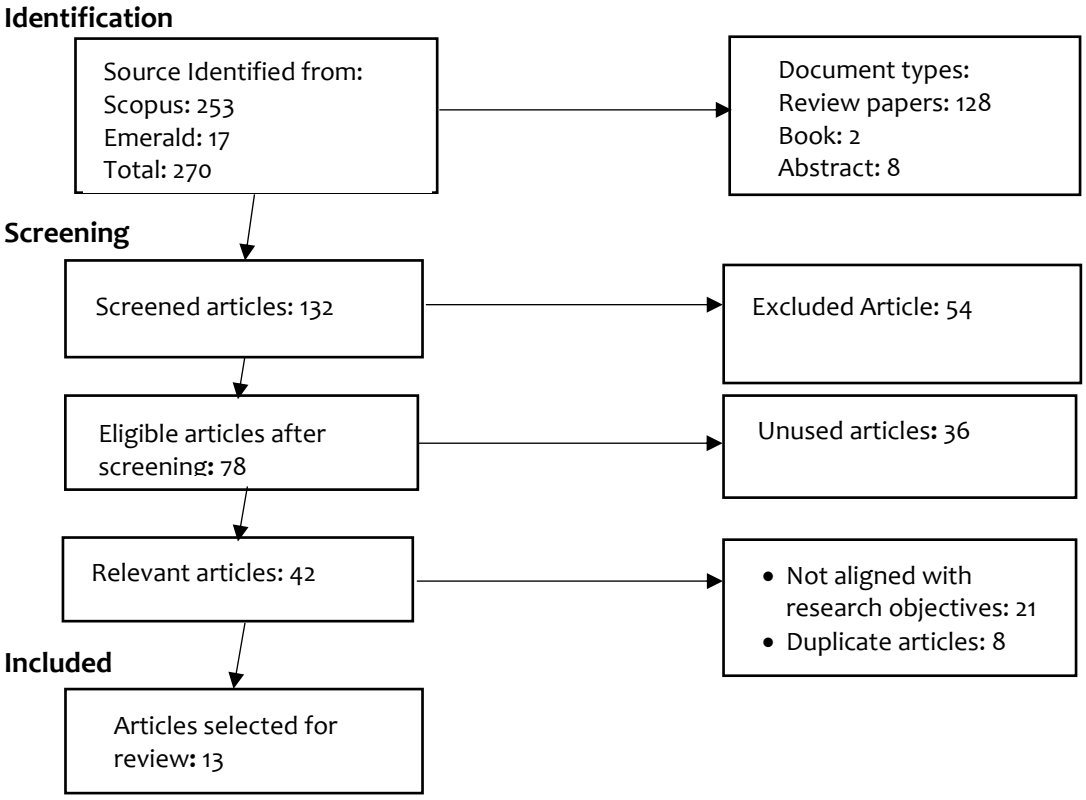

Table 3. Summary of Research Articles Relevant to This Study

No.	Researcher	Objective
1	Huang et al., 2020	Creative thinking involves flexibility, fluency, novelty, and elaboration.
2	Suherman & Vidákovich, 2022	Tools for assessing MCT often utilize open-ended questions, interviews, multiple-choice questions, questionnaires, and open-ended inquiry-based assessments.
3	Sun et al., 2020	The results indicate that students' scientific creativity performance improved after training. Moreover, students with both high and low levels of creative potential benefited from the training. However, those with higher domain knowledge levels gained more from the training compared to those with lower domain knowledge.
4	Segundo Marcos et al., 2020	The findings align with the idea that creative thinking (divergent thinking) can be enhanced through reading and writing activities implemented via cooperative learning among school-aged children.
5	Dilekçi & Karatay, 2023	The study results demonstrate that these activities significantly enhance students' creative thinking skills. Additionally, students' learning motivation, innovation skills, and technological and digital literacy competencies improved.

No.	Researcher	Objective
6	Henriksen et al., 2020	Mindfulness practices can support creativity.
7	Saad & Zainudin, 2022	Effective computational thinking (CT) enhances teaching and learning while also improving students' computational thinking skills. Thinking skills are essential 21st-century competencies necessary for student success.
8	Relkin et al., 2021	A developmentally appropriate curriculum for teaching young children to code can accelerate their acquisition of computational thinking skills.
9	Su & Yang, 2023	Children can develop early computational thinking concepts and skills, along with related abilities such as communication, collaboration, and problem-solving. Among these studies, most employed quantitative research methods, with assessment and direct observation being the most commonly used approaches.
10	Liu et al., 2023	The findings indicate that, compared to behavioral engagement, both emotional and cognitive engagement are stronger predictors of computational thinking.
11	Cheng et al., 2020	The actual coding contributions within repositories exhibit a negative correlation with students' attention. This suggests that students tend to imitate rather than innovate.
12	Bai et al., 2023	As a widely used social code-hosting platform, GitHub encourages developers to engage in discussions and provide insights on various issues.
13	Zhao et al., 2024	Our findings indicate that: i) Usability and functionality are the most frequently interacting quality attributes with accessibility, appearing in over 66% of cases. ii) 87% of interaction issues violate the Perceivable and Operable principles in the Web Content Accessibility Guidelines (WCAG), iii) The primary causes of these interaction issues are UI Component Related (UCR) and Contrast Related (CR) problems, which occur in more than 52% of cases.

Source: Processed by the Researcher, 2025

Enhancement of Creative Thinking

From the 13 articles identified as relevant and suitable for this research, 6 articles focus on the enhancement of students' creative thinking. These 6 articles include (Behnamnia et al., 2020; Dilekçi & Karatay, 2023; Huang et al., 2020; Segundo Marcos et al., 2020; Suherman & Vidákovich, 2022; Sun et al., 2020). These articles discuss the role of education in improving students' creative thinking skills. Five key points are emphasized in these 6 articles:

1. Education and training should be designed to develop students' creative thinking skills through various effective methods.
2. It is important to consider students' domain knowledge levels when designing creativity interventions.
3. The integration of reading, writing, and cooperative learning activities can be an effective strategy for enhancing creative thinking.
4. Comprehensive assessment techniques are needed to measure and monitor the development of creative thinking skills.
5. Self-awareness or mindfulness exercises can be a way to enhance creativity.

Computational Thinking (CT) Learning

From the 13 articles analyzed, 4 articles discuss computational thinking (CT) learning for students. These 4 articles include (Liu et al., 2023; Relkin et al., 2021; Saad & Zainudin, 2022; Su & Yang, 2023). These articles explain that education needs to integrate CT learning into the curriculum to equip students with relevant skills in today's digital era. The designed curriculum should focus on students' technical, emotional, and cognitive skills in CT learning.

GitHub Platform

From the 13 articles analyzed, 3 articles discuss the role of the GitHub platform in supporting the learning of students specializing in Software Engineering (RPL) in the classroom. These 3 articles are from (Bai et al., 2023; Cheng et al., 2020; Zhao et al., 2024). These articles explain that educators need to design learning strategies that encourage students' innovation and creativity in using GitHub, rather than merely copying existing code. Additionally, GitHub's development should enhance platform accessibility, especially regarding UI components and contrast, to ensure it can be used by all students.

DISCUSSION

From the analysis of 13 research articles, the researcher found that at the vocational high school (SMK) level with a Software Engineering (RPL) specialization,

there is a need for changes in classroom teaching practices. Teaching should place greater emphasis on developing creative thinking skills through a holistic and integrated approach (Henriksen et al., 2020). To achieve this approach, the curriculum for computational thinking (CT) learning must be comprehensive and relevant to current digital technology developments. A relevant curriculum update aligned with technological advancements can create effective teaching that enhances student engagement. According to Zhao (2024), effective learning that aligns with digital technology developments can also improve students' skill accessibility through the GitHub platform. GitHub provides an effective teaching system for collaborative and innovative learning (Bai et al., 2023).

The findings of this literature study align with constructivist theory, which states that students construct their own knowledge through experience and interaction with their environment (Efgivia et al., 2021). Computational thinking teaches students to break down complex problems into smaller parts, think algorithmically, and evaluate solutions (Saad & Zainudin, 2022). Meanwhile, the use of GitHub allows students to learn through hands-on practice in developing and managing programming projects (Cheng et al., 2020). Thus, the use of computational thinking learning strategies with GitHub in RPL vocational education supports constructivist theory by creating an experience-based learning environment, fostering collaboration, encouraging creativity, and facilitating independent learning.

CONCLUSION

From the analysis of 13 research articles, the researcher found that at the vocational high school (SMK) level with a Software Engineering (RPL) specialization, there is a need for changes in classroom teaching practices. Teaching should place greater emphasis on developing creative thinking skills through a holistic and integrated approach (Henriksen et al., 2020). To achieve this approach, the curriculum for computational thinking (CT) learning must be comprehensive and relevant to current digital technology developments. A relevant curriculum update aligned with technological advancements can create effective teaching that enhances student engagement. According to Zhao (2024), effective learning that aligns with digital technology developments can also improve students' skill accessibility through the GitHub platform. GitHub provides an effective teaching system for collaborative and innovative learning (Bai et al., 2023).

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