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Integration of STEAMS-based Design Thinking to Enhance Critical Thinking and Collaboration Skills of Fifth-Grade Elementary School Students: A Literature Review

Ratna Sari Dewi[1], Slamet Arifin[2], Siti Faizah[3], Riska Pristiani[4]*
[1, 2, 3, 4]*State University of Malang, Malang, Indonesia*

Abstract
Critical thinking and collaboration skills are essential 21st-century competencies that remain relatively low among elementary school students in Indonesia. The STEAM approach integrated with Design Thinking is considered promising for developing these two skills; however, the social element has not yet been explicitly incorporated into the framework. This study aims to analyze the potential of STEAMS (adding the Social element) integration based on Design Thinking in enhancing critical thinking and collaboration skills of grade V elementary school students. The method employed is a literature review, analyzing ten relevant national and international journal articles. Data analysis used content analysis techniques. The results indicate that the Design Thinking-based STEAM approach significantly enhances critical thinking skills with a large effect size (d=0.98) and collaboration skills with a 34% improvement (d=1.73). Improvements in critical thinking sub-skills include interpretation, analysis, inference, information search, creative reasoning, as well as reflection and self-regulation. Enhanced collaboration sub-skills include perspective-taking (d=1.89), conflict resolution (d=1.67), communication effectiveness (d=1.54), and shared responsibility (d=1.42). Studies specifically targeting grade V elementary school students reported significant improvements in interpretation, analysis, and inference skills (Z=-3.982, p=0.00). Social dimensions such as empathy and self-confidence also developed through the Design Thinking process. Thus, STEAMS based on Design Thinking holds great potential for enhancing critical thinking and collaboration skills of grade V elementary school students.

Keywords: STEAMS; design thinking; critical thinking; collaboration

Abstrak
Keterampilan berpikir kritis dan kolaborasi merupakan kompetensi esensial abad 21 yang masih tergolong rendah pada siswa sekolah dasar di Indonesia. Pendekatan STEAM yang diintegrasikan dengan *design thinking* dinilai potensial untuk mengembangkan kedua keterampilan tersebut, namun unsur sosial belum secara eksplisit menjadi bagian dari kerangka yang digunakan. Penelitian ini bertujuan untuk menganalisis potensi integrasi STEAMS berbasis *design thinking* dalam meningkatkan keterampilan berpikir kritis dan kolaborasi siswa kelas V SD. Metode yang digunakan adalah studi literatur, menganalisis sepuluh artikel jurnal nasional dan internasional yang relevan. Teknik analisis data menggunakan analisis isi. Hasil penelitian menunjukkan bahwa pendekatan STEAM berbasis *design thinking* secara signifikan meningkatkan keterampilan berpikir kritis dengan *effect size* besar (d=0,98) dan keterampilan kolaborasi dengan peningkatan 34% (d=1,73). Peningkatan terjadi pada subketerampilan berpikir kritis meliputi interpretasi, analisis, inferensi, pencarian informasi, penalaran kreatif, serta refleksi dan regulasi diri. Subketerampilan kolaborasi yang meningkat meliputi pengambilan perspektif (d=1,89), resolusi konflik (d=1,67), efektivitas komunikasi (d=1,54), dan tanggung jawab bersama (d=1,42). Penelitian pada siswa kelas V SD secara spesifik melaporkan peningkatan signifikan pada kemampuan interpretasi, analisis, dan inferensi (Z=-3,982, p=0,00). Dimensi sosial seperti empati dan kepercayaan diri juga berkembang melalui proses *design thinking*. Dengan demikian, STEAMS berbasis *design thinking* memiliki potensi besar untuk meningkatkan keterampilan berpikir kritis dan kolaborasi siswa kelas V SD.

Kata Kunci: STEAMS; design thinking; berpikir kritis; kolaborasi

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***Correspondence:**
Ratna Sari Dewi
ratna.sari.2521038@students.um.ac.id

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INTRODUCTION

The 21st century demands that every individual master essential competencies known as 21st-century skills, which encompass critical thinking, creativity, communication, and collaboration (4C skills). Critical thinking and collaboration skills constitute two fundamental competencies that must be cultivated from elementary education, considering that these abilities serve as the foundation for individual success in confronting increasingly complex global challenges (Sari et al., 2024). Elementary school students, particularly those in fifth grade within the age range of 10-11 years, are in a transitional period from the concrete operational stage toward the formal operational stage according to Piaget's theory of cognitive development. At this stage, children begin to think abstractly yet still require concrete experiences in the learning process. Nevertheless, various international surveys such as the Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) consistently demonstrate that Indonesian students' critical thinking abilities remain in the low category compared to other countries (PISA, 2023; Von Davier et al., 2024). Furthermore, collaboration skills are rarely an explicit target in fifth-grade elementary school classrooms, despite the fact that the ability to work in teams constitutes one of the primary demands of the future workforce. This fact indicates a significant gap between the demands of 21st-century skills and the reality of learning currently taking place in elementary schools.

One learning approach deemed promising for developing 21st-century skills is the STEAM approach, which integrates Science, Technology, Engineering, Arts, and Mathematics into a holistic learning framework. Research demonstrates that the STEAM approach encourages students to think critically through hands-on activities and collaborative projects (Zakaria & Osman, 2024). Furthermore, the development of STEAM into STEAMS with the addition of the "S" element (Social) further enriches the learning dimension by incorporating social values as an integral part of the scientific thinking process. However, the implementation of STEAMS in elementary schools faces significant challenges. A systematic literature review conducted by Zakaria & Osman (2024) revealed that although integrated STEAM approaches are most effective in elementary school curricula, teachers tend to teach STEAM components separately without meaningful integration across disciplines (Ahmad Dani et al., 2025). Consequently, the potential of STEAMS to develop critical thinking and collaboration skills has not been optimally realized. In fact, integrated STEAM learning has been proven to significantly enhance students' creativity and problem-solving abilities, as well as provide benefits for diverse populations including students in underserved areas and students with special needs through curricula and teaching methods adapted to promote inclusivity (Jasmaniah, 2025).

To address the integration challenges in the STEAMS approach, a framework is needed that can serve as a "glue" across disciplines while simultaneously guiding a systematic learning process. Design Thinking (DT) offers a cyclical process consisting of five stages: empathize, define, ideate, prototype, and test. This approach is human-centered and collaborative, which is highly compatible with the characteristics of fifth-grade elementary school students who are beginning to think abstractly yet still require concrete and meaningful activities. Research conducted by Van Gompel (2019) through an exploratory case study in third-grade elementary classrooms found that Design Thinking as a pedagogical strategy effectively helped students strengthen 21st-century skills, including critical thinking, communication, collaboration, and creativity, while simultaneously learning academic content. This finding is reinforced by the results of research by Sunday et al. (2025) demonstrating that integrated computational thinking-design thinking (CT-DT) modules were able to foster co-creation by promoting 21st-century competencies—creativity, critical

thinking, collaboration, and communication—among elementary school students, with quantitative results indicating statistically significant improvements in creativity and critical thinking. Thus, Design Thinking has the potential to serve as an effective integration framework for unifying various disciplines within STEAMS into a coherent and meaningful learning experience.

Although the literature on STEAM and Design Thinking has developed rapidly over the past decade, there remains a significant research gap regarding their integration specifically aimed at enhancing critical thinking and collaboration skills among fifth-grade elementary school students. Empirical research on the combination of STEAMS with the Design Thinking approach remains very limited, particularly that which specifically targets fifth-grade elementary school student populations while considering their cognitive developmental characteristics (Van Gompel, 2019). Furthermore, the systematic literature review conducted by Zakaria & Osman (2024) acknowledges that no study has systematically reviewed the existing literature at the elementary school level to identify, develop, and implement innovative methodologies and practices in STEAM education to enhance creativity, critical thinking, and problem-solving skills. Meanwhile, a systematic review of the STEM approach to 4C skills in elementary school students concluded that the products generated could be categorized into three groups: simple technology, simple technology from recycled materials, and prototypes; however, this review has not specifically integrated Design Thinking as a process framework (Sari et al., 2024). Thus, no literature study has systematically synthesized theoretical and empirical evidence on how the mechanism of STEAMS integration based on Design Thinking operates within the 10-11 year age range to simultaneously enhance both critical thinking and collaboration skills.

This literature study offers novelty by not merely summarizing existing findings, but rather analyzing in depth how the mechanism of STEAMS integration based on Design Thinking can trigger improvements in critical thinking and collaboration skills among fifth-grade elementary school students. Unlike previous studies that tend to discuss STEAM and Design Thinking separately or focus on a single variable, this research specifically connects theoretical synthesis with the cognitive developmental characteristics of fifth-grade elementary school students who are in the transition from concrete operational to formal operational stages. Another novelty lies in the effort to identify the necessary conditions for effective integration, such as adequate learning duration, the teacher's role as facilitator, appropriate project types, and the adaptation of Design Thinking stages to the cognitive developmental level of elementary school-aged children. Previous research by Van Gompel (2019) demonstrated that Design Thinking requires deliberate effort from teachers for successful classroom implementation, and this finding will be one of the focal points of analysis in this literature study. Additionally, this study will examine how a transdisciplinary approach in STEAMS can facilitate the development of collaboration skills through project-based activities structured within the Design Thinking framework (Rahmaniati, 2026). Through this analytical approach, the literature study is expected to make a significant theoretical contribution to the development of innovative learning models in elementary schools.

Based on the background of the problem and the research gaps outlined above, this literature study aims to analyze and synthesize findings from various literature sources regarding the integration of STEAMS based on Design Thinking in enhancing critical thinking and collaboration skills among fifth-grade elementary school students. This literature study is expected to provide benefits by offering a comprehensive literature map of STEAMS and Design Thinking integration in elementary schools, while simultaneously formulating a conceptual framework that can serve as a

foundation for subsequent researchers wishing to conduct empirical studies in this field.

RESEARCH METHOD

This research employs a qualitative approach with a literature study or library research type. The literature study method was chosen because it enables researchers to systematically examine various relevant bibliographic sources to build a robust theoretical and conceptual foundation regarding the research topic (Annasthasya et al., 2025). In the context of this research, the literature study is used to examine various previously published research findings related to the integration of STEAMS (Science, Technology, Engineering, Arts, Mathematics, and Society), the application of Design Thinking at the elementary school level, and the impact of both approaches on critical thinking and collaboration skills of fifth-grade elementary school students.

The data sources in this research are derived from scientific articles published in nationally accredited journals as well as international journals. The number of articles analyzed was 10, obtained through academic databases such as Google Scholar, ERIC, and ScienceDirect. The article search process was conducted using relevant keywords, including: "STEAMS elementary school," "design thinking primary education," "critical thinking elementary students," "collaboration skills 5th grade," and "integrating STEAM with design thinking" (Annasthasya et al., 2025). The collected articles were subsequently analyzed to identify various concepts, strategies, and empirical findings supporting the understanding of the research topic.

The data collection technique employed was documentation. This technique was implemented through activities including collecting relevant scientific articles, reading the entire content of the articles carefully and repeatedly, and recording important information aligned with the research focus (Sugiyono, 2013). The supporting instrument used was an article analysis sheet or literature synthesis table. This table contained the following components: author name and year of publication, article title, research objectives, research methods, and key findings related to STEAMS integration, Design Thinking implementation, critical thinking skills, and collaboration skills among fifth-grade elementary school students (Habibah, 2023). With this instrument, research data could be organized systematically to facilitate subsequent analysis.

The data analysis technique in this research employed content analysis. Content analysis was conducted by thoroughly examining the content of each collected scientific article, then identifying key concepts, research findings, and relevant information that addressed the research objectives (Annasthasya et al., 2025). The data analysis steps undertaken included: (1) Collecting scientific articles that met the criteria; (2) Reading and comprehensively understanding the article content; (3) Identifying research findings related to STEAMS integration, Design Thinking, critical thinking, and collaboration; (4) Grouping data based on themes or research variables; (5) Synthesizing across articles to identify patterns, similarities, and differences in findings; and (6) Drawing conclusions based on the synthesized literature analysis. Through this systematic analytical procedure, it was expected that a comprehensive and holistic picture would be obtained regarding how the integration of STEAMS based on Design Thinking can enhance critical thinking and collaboration skills among fifth-grade elementary school students.

RESULTS AND DISCUSSION

Results

Below, the researcher presents the results of the analysis of 10 relevant articles, from both national and international journals, collected from various database sources. The presentation is provided in tabular form containing the following components: researcher name and year, research title, research objectives, research method, and research findings.

Table 1. Article Analysis

No	Peneliti	Title	Objectives	Method	Findings
1	Kholid (2026)	*Technology-Enhanced Co-Creative Pedagogies: Transforming Collaboration, Critical Thinking, and Innovation in STEAM Education*	To investigate how technology-enhanced co-creative pedagogical frameworks improve collaboration, critical thinking, and innovation in STEAM learning environments	Mixed-methods (quasi-experimental with n=285), utilizing digital collaborative platforms, VR simulations, and AI-assisted peer mentoring systems	Students in technology-enhanced co-creative environments demonstrated superior critical thinking performance (M=78.4) compared to traditional approaches (M=65.7). Collaboration increased by 34%. Innovation showed substantial improvement (d=0.82 for technological originality).
2	Yalçın (2024)	*Design-Oriented Thinking in STEM Education: Exploring the Impact on Preschool Children's Twenty-First-Century Skills*	To examine the effect of design-oriented STEM activities on 21st-century skills of preschool children (aged 5)	Mixed-method with experimental design (pretest-posttest-persistence test), 45 children (23 experimental, 22 control)	Design-oriented STEM activities permanently increased the total 21st-century skills scores of children in the experimental group. Significant improvements were observed in all sub-dimensions: learning and innovation skills (4Cs), life and career skills, and information, media and technology skills.
3	Ananda, Rahmawati & Khairi (2023)	*Critical Thinking Skills of Chemistry Students by Integrating Design Thinking with STEAM-PjBL*	To develop students' critical thinking skills through integrating Design Thinking with STEAM-PjBL in chemistry redox reaction material	Qualitative (41 high school students), with observation, reflective journals, interviews, and researcher notes. Utilized 5 stages of Design Thinking	Students' critical thinking skills developed to advanced levels in three categories: information searching, creative interpretation and reasoning, and reflection and self-regulation. Design Thinking helped students actively create project-based solutions.
4	Gürler & Kaplan (2023)	*Attitudes Towards STEAM, Critical Thinking Disposition and Decision-Making Skills: Mediation and Gender Moderation*	To examine the relationship between attitudes toward STEAM, critical thinking disposition, and decision-making skills of 4th-grade elementary students, and the role of gender as moderator	Quantitative cross-sectional (n=650 fourth-grade students), using Structural Equation Modeling (SEM) and multigroup analysis	Attitudes toward STEAM had a direct effect on decision-making skills (β=0.178). Critical thinking disposition partially mediated this relationship (β=0.419). Gender moderated the relationship with indirect effects greater for males (β=0.435) than females (β=0.414).
5	Khan, Kazi & Butt (2023)	*Influence of Design Thinking in Integrated STEAM Inquiry-Based Learning on Primary School Students' Empathy and Confidence*	To explore the influence of Design Thinking in integrated STEAM inquiry-based learning on developing empathy and confidence of 5th-grade elementary students	Qualitative descriptive with case study (28 fifth-grade students from underprivileged schools), rubric observation, semi-structured interviews over 3 months	Design Thinking in STEAM developed students' empathy and self-confidence. Students demonstrated high collaboration, effective communication, and problem-solving abilities. Design Thinking fostered empathy by making students consider user perspectives.
6	Cooke (2022)	*The Impact of Design Thinking and STEAM Learning on Student Engagement*	To evaluate the impact of STEAM and Design Thinking learning on elementary school student engagement	Action research with mixed methods (focus group Year 4, 0-6 years), using Leuven Well-being and Involvement Scale	STEAM and Design Thinking positively increased student engagement through: encouraging curiosity, open-ended questions, hands-on activities, explicit teaching, and reflective journals. Collaboration and digital tool use also enhanced engagement.
7	Indriyana & Susilowati (2020)	*The Effects of Model Project-Based Learning Approach on STEM on Natural Science Learning to*	To analyze the effect of the PjBL model on the STEM approach on critical thinking and cooperation skills	Quasi-experimental with non-equivalent control group design (8th grade, n=128)	PjBL-STEM was effective in improving critical thinking and cooperation skills with moderate effect category. Aspects of interpretation, analysis, evaluation,

No	Peneliti	Title	Objectives	Method	Findings
		Junior High School Student's Critical Thinking Skills and Cooperative Skills at SMP N 1 Berbah	of junior high school students		and inference in the experimental class were higher than the control. Cooperation included contribution, responsibility, and maximum effort.
8	Indriyana & Susilowati (2020)	*The Effects of Model Project-Based Learning Approach on STEM on Science Learning to Junior High School Student's Critical Thinking Skills and Cooperative Skills*	To analyze the effect of project-based learning model on STEM approach on critical thinking and cooperation skills of junior high school students	Quasi-experimental with non-equivalent control group design (8th grade, n=128). Experimental class: PjBL-STEM, control: scientific approach	There was a significant effect of the PjBL-STEM model on critical thinking (Sig=0.029) and cooperation skills (Sig=0.028). Effect size in the moderate category (0.55 for critical thinking, 0.56 for cooperation). N-Gain of experimental class (0.41) was higher than control (0.28).
9	Gencer & Dogan (2020)	*The Assessment of the Fifth-Grade Students' Science Critical Thinking Skills through Design-Based STEM Education*	To develop and validate a science critical thinking skills instrument and assess improvement through design-based STEM education in 5th-grade students	Design-based research (22 fifth-grade students), with kappa test for content validity, EFA and CFA for construct validity, and Wilcoxon test	STEM modules significantly improved students' science critical thinking skills (Z=-3.982, p=0.00) in sub-skills of interpretation, analysis, and inference. The infusion approach was effective for teaching critical thinking in science contexts.
10	Klyn (2018)	*STEAM Design Thinking and Innovation: A Collaborative, Interdisciplinary, Authentic Approach to Problem Solving in Mathematics*	To develop an interdisciplinary mathematics curriculum integrating collaboration and Design Thinking to equip students in solving authentic and complex problems	Curriculum development (design-based research) with pilot testing on 9-28 high school students	STEAM DTI curriculum produced 6 major shifts: from product to process, consumption to production, teacher-centered to student-centered, competition to collaboration, risk avoidance to risk-taking, and single-discipline to interdisciplinary thinking.

Discussion

Rationale for Adding the Social Element to STEAM

The ten articles analyzed in this literature study predominantly examined STEM or STEAM approaches without explicitly including the social element as a separate component. Nevertheless, various findings from these studies indirectly indicate that social aspects were actually present and played a significant role in the successful implementation of Design Thinking-based STEAM. This suggests that the addition of the "S" element to form STEAMS (Science, Technology, Engineering, Arts, Mathematics, and Social) is not an artificial step, but rather a formal recognition of the social dimension that is naturally embedded in the collaborative learning and contextual problem-solving process.

Kholid's research (2026) reported that technology-enhanced co-creative learning environments produced a 34% increase in collaboration with a very large effect size (d=1.73) across all collaboration sub-dimensions, including perspective-taking, conflict resolution, communication effectiveness, and shared responsibility. These findings clearly demonstrate that social dimensions—such as the ability to understand others' viewpoints, resolve differences of opinion, and work in teams—are outcomes intrinsically linked to the approach employed. Thus, explicitly integrating the social element into the STEAMS framework would strengthen the foundation for developing social skills that have thus far been considered "bonuses" of STEAM learning.

The research by Khan et al. (2023), which specifically examined fifth-grade elementary school students in Pakistan over three months, found that the Design Thinking process in inquiry-based STEAM learning developed

students' empathy and self-confidence. All groups demonstrated high levels of collaboration, effective communication, and good problem-solving abilities. The Design Thinking process fostered empathy by consistently having students consider user perspectives in every design decision they made. These findings reinforce the argument that the presence of social elements, particularly empathy, is not complementary but rather an essential component determining the quality of solutions produced by students. Therefore, formal recognition of the social element in STEAMS would help teachers and students become more aware and intentional in developing social competencies throughout the learning process.

The Role of Design Thinking as an Integration Framework for STEAMS

Design Thinking serves as an effective integration framework for unifying various disciplines within STEAMS while simultaneously developing critical thinking and collaboration skills. The research by Ananda et al. (2023) demonstrated how the five stages of Design Thinking are integrated with STEAM-PjBL. The empathize stage builds concern for contextual problems (including social issues), the define stage formulates the focus of the problem considering user needs, the ideate stage generates creative solutions through teamwork, the prototype stage realizes solutions in tangible form, and the test stage evaluates solution effectiveness with users. Within the STEAMS framework, each stage can be enriched with social dimensions, for example by involving the community in the testing process or soliciting feedback from vulnerable groups targeted by the solution.

Klyn's research (2018) developed a STEAM Design Thinking and Innovation curriculum that produced six paradigmatic shifts in learning: from product to process, consumption to production, teacher-centered to student-centered, competition to collaboration, risk avoidance to risk-taking, and single-discipline to interdisciplinary thinking. These shifts toward collaboration and process align with the essence of STEAMS, which emphasizes the importance of social interaction and cooperation in solving complex problems. The curriculum also emphasized the importance of connecting students' work with local and global communities, representing a tangible manifestation of the social element.

Cooke's research (2022) emphasized that Design Thinking provides a systematic framework for students to discover solutions to problems they face through inquiry-based learning. Interconnected thinking modes allow students to enter and exit each mode as needed, making iterative refinements. With its emphasis on empathy, Design Thinking becomes a valuable social-emotional commodity for all individuals, including fifth-grade elementary school students who are developing their empathic abilities. In STEAMS, this iterative process also trains students to reflect on the social impact of each solution iteration they produce, so they learn not to be easily satisfied and continue striving to refine solutions for the common good.

The research by Gencer & Dogan (2020) emphasized the importance of the infusion approach, which integrates explicit teaching of critical thinking skills into the context of science subjects rather than teaching them separately. The same approach can be applied in STEAMS, where collaboration skills and social awareness are explicitly taught within the context of design-based problem-solving. This is important because fifth-grade elementary school students still require guidance and concrete examples to understand what constitutes "good collaboration" or "considering others' needs."

Potential of Design Thinking-Based STEAMS in Enhancing Critical Thinking Skills

The synthesis of the ten analyzed articles demonstrates that the STEAM approach integrated with Design Thinking holds great potential for developing students' critical thinking skills. Although most articles have not explicitly included the social element within the STEAM framework, various findings indicate that social dimensions are naturally present in the collaborative learning and design-based problem-solving process. The addition of the "S" element to form STEAMS would further strengthen the foundation for developing critical thinking skills oriented toward the common good and awareness of the social impact of each solution produced.

Kholid's research (2026) reported that technology-enhanced co-creative learning environments produced significant improvements in critical thinking skills with an effect size of d=0.98, considered large in the context of educational interventions. This finding demonstrates that the approach integrating technology, collaboration, and creativity—characteristic of STEAMS—is highly effective in developing higher-order cognitive capacities among fifth-grade elementary school students. Furthermore, the research by Gencer & Dogan (2020), which specifically examined fifth-grade elementary school students, reported that design-based STEM modules significantly improved students' critical thinking skills across all sub-skills, namely interpretation, analysis, and inference (Z=-3.982, p=0.00). This finding reinforces the argument that Design Thinking-based STEAMS holds great potential for implementation at the fifth-grade elementary school level.

The research by Ananda et al. (2023) provides a more detailed picture of the mechanism for improving critical thinking skills through the integration of Design Thinking with STEAM-PjBL. This qualitative study revealed that students' critical thinking skills developed to advanced levels in three main categories: information searching, creative interpretation and reasoning, and reflection and self-regulation. The five stages of Design Thinking (empathize, define, ideate, prototype, and test) were proven to provide a systematic framework for students to develop critical thinking abilities progressively. In the STEAMS context, the addition of the social element would enrich the information searching process with data about community needs, as well as deepen reflection on the social impact of the designed solutions.

The research by Gürler & Kaplan (2023) found that positive attitudes toward STEAM had a direct effect on decision-making skills (β=0.178), as well as an indirect effect through critical thinking disposition (β=0.419). This finding indicates that when students have positive attitudes toward STEAM learning, their tendency to think critically also increases, ultimately impacting their ability to make appropriate decisions. For fifth-grade elementary school students, developing critical thinking disposition from an early age is crucial because it will shape thinking habits that will carry through to subsequent educational levels.

The research by Indriyana & Susilowati (2020) reported that the integrated PjBL-STEM model had a significant effect on junior high school students' critical thinking skills with a significance value of 0.029. Although this research was conducted at the junior high school level, its underlying principles remain relevant for fifth-grade elementary school students. Students in the 10-11 year age range are in a transition from the concrete operational stage to the formal operational stage according to Piaget's theory, so they are beginning to think abstractly and engage in logical reasoning. The Design Thinking-based STEAMS approach involving

contextual problem-solving is highly appropriate for this cognitive developmental stage.

Potential of Design Thinking-Based STEAMS in Enhancing Collaboration Skills

The literature synthesis also reveals strong evidence that the STEAM approach integrated with Design Thinking holds great potential for developing students' collaboration skills. Kholid & Supriyadi's research (2026) reported a 34% improvement in collaboration with a very large effect size (d=1.73). Further analysis showed that improvements occurred across all collaboration sub-dimensions: perspective-taking (d=1.89), conflict resolution (d=1.67), communication effectiveness (d=1.54), and shared responsibility (d=1.42). These four sub-dimensions are essential components of social skills that fifth-grade elementary school students need in working with peers, teachers, and other community members. The addition of the social element to STEAMS would further strengthen the development of these four sub-dimensions in a structured and measurable manner.

The research by Khan et al. (2023), which specifically examined fifth-grade elementary school students in Pakistan, found that the Design Thinking process in inquiry-based STEAM learning developed students' empathy and self-confidence. All groups demonstrated high levels of collaboration, effective communication, and good problem-solving abilities. The Design Thinking process fostered empathy by consistently having students consider user perspectives in every design decision. This finding is highly relevant to the fifth-grade elementary school context because at this age students begin to develop the ability to understand others' feelings and perspectives (theory of mind). STEAMS with an emphasis on the social element would help students not only to work together mechanically but also to develop care and responsibility toward others.

Cooke's research (2022) reported that STEAM and Design Thinking learning positively increased student engagement, with supporting factors including encouraging curiosity, use of open-ended questions, hands-on activities, and collaboration and use of digital tools. This finding indicates that when students are actively and collaboratively engaged in learning, they tend to develop better social skills. In the STEAMS context, this active engagement can be extended by involving community members, parents, or local figures as resource persons or project partners, so students learn to collaborate not only with classmates but also with various stakeholders in their surrounding environment.

The research by Indriyana & Susilowati (2020) revealed that cooperation skills encompass three main aspects: contribution (providing ideas and solutions), responsibility (carrying out tasks according to individual roles), and exerting maximum effort (completing projects on time and helping each other). These three aspects developed better in the experimental class using the PjBL-STEM model compared to the control class using a conventional scientific approach. This finding indicates that project-based approaches integrated with STEM (and subsequently STEAMS) are more effective in developing collaboration skills compared to lecture-based or individual learning approaches. For fifth-grade elementary school students, the development of these three collaboration aspects is crucial because they form the foundation for success in project-based learning at subsequent educational levels.

Yalçın's research (2022) on preschool children demonstrated that design-oriented STEM activities permanently improved children's 21st-century skills, including life and career skills as well as social and cross-cultural skills. This finding is important because it shows that social dimensions can be developed from an early age

through design-based approaches. For fifth-grade elementary school students, the development of social and cross-cultural skills can be achieved by designing projects involving interaction with peers from different backgrounds or learning how the same problem is solved in different cultures, which is part of the social element in STEAMS.

Opportunities for Implementing Design Thinking-Based STEAMS in Fifth-Grade Elementary School

The implementation of Design Thinking-based STEAMS in fifth-grade elementary school presents enormous opportunities considering the cognitive and social developmental characteristics of students at this age. The research by Gencer & Dogan (2020) demonstrated that design-based STEM modules developed for fifth-grade students were effective in improving critical thinking skills. This success indicates that fifth-grade elementary school students are capable of following higher-order thinking processes when supported by appropriate approaches. STEAMS with the addition of the social element would further enrich students' learning experiences because they not only learn abstract concepts but also see real-world applications in their social lives.

The research by Khan et al. (2023) reported that fifth-grade elementary school students from underprivileged schools showed improvements in empathy and self-confidence after participating in Design Thinking-based STEAM learning over three months. This finding is important because it demonstrates that this approach is effective not only for students from middle-to-upper socioeconomic backgrounds but also for students from less privileged families. Thus, Design Thinking-based STEAMS has the potential to become an inclusive and socially just approach, highly relevant to the Indonesian context with its socioeconomic diversity.

Klyn's research (2018) developed a STEAM DTI curriculum designed to reach all students regardless of their computational-procedural skill backgrounds. This curriculum opened access for students who typically could not enroll in advanced courses such as AP Calculus to still develop higher-order thinking skills through authentic problem-solving. In the STEAMS context in Indonesia, a similar approach could be applied to address access gaps to quality education, especially for students in underserved and frontier areas.

Cooke's research (2022) also highlighted the importance of creating a community of practice among teachers to support STEAM implementation. The same can be applied to STEAMS, where fifth-grade elementary school teachers can share experiences, resources, and strategies for integrating social elements into design-based learning. This community of practice can be facilitated through teacher working groups, online forums, or partnership programs with universities and research institutions.

Overall, the ten articles analyzed in this literature study collectively demonstrate that the STEAM approach (and its extension STEAMS) integrated with Design Thinking holds tremendous potential for enhancing critical thinking and collaboration skills among fifth-grade elementary school students. Although these studies have not explicitly included the social element, various findings indicate that social dimensions are intrinsically present in the collaborative learning and design-based problem-solving process. The addition of the social element to form STEAMS would further strengthen this potential by making social awareness, empathy, and collective responsibility structured and measurable components of learning. Thus, Design Thinking-based STEAMS is worthy of recommendation as an innovative approach in elementary education in Indonesia.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the discussion of ten articles, it can be concluded that the integration of Design Thinking-based STEAMS holds great potential for enhancing critical thinking and collaboration skills among fifth-grade elementary school students. Although the studies analyzed predominantly still employ STEM or STEAM frameworks without explicitly including the social element, various findings indicate that social dimensions—such as empathy, perspective-taking, conflict resolution, effective communication, and shared responsibility—are naturally present and play important roles in the successful implementation of this approach. The addition of the "S" element to form STEAMS represents a formal recognition of the social dimension that has thus far been an inseparable part of collaborative learning and contextual problem-solving. The five stages of Design Thinking (empathize, define, ideate, prototype, and test) are proven effective as a systematic integration framework for developing both skills progressively and sustainably.

Recommendations

Several recommendations the researcher proposes include: (1) For Future Researchers: It is recommended to conduct empirical research in fifth-grade elementary school classrooms in Indonesia that explicitly integrates the social element into STEAM, thereby forming Design Thinking-based STEAMS. Experimental research with a pretest-posttest control group design is needed to measure the effect size of this approach on improving critical thinking and collaboration skills; (2) For Teachers: Fifth-grade elementary school teachers should begin implementing the Design Thinking-based STEAMS approach gradually, emphasizing the development of empathy, social awareness, and teamwork. Explicit instruction on collaboration and critical thinking skills needs to be provided, not merely assumed to develop on their own; and (3) For Curriculum Developers: The elementary school curriculum needs to accommodate the integration of social elements into STEAM learning, for example by incorporating contextual social issues (environmental cleanliness, access equity, care for vulnerable groups) as design challenges that students must solve.

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