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THE ROLE OF ART COMPONENTS IN IMPROVING UNDERSTANDING OF GEOMETRY AND ALGEBRA CONCEPTS: A SYSTEMATIC STEAM LEARNING APPROACH

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Abstract

Geometry and algebra learning remains a challenge for many students due to its abstract nature and the need for strong visualization and symbolic representation skills. The integration of art components into the STEAM approach offers a pedagogical solution that can bridge this gap through visual representation, creativity, and the construction of more concrete meaning. This research is a systematic literature review of 20 articles published between 2018 and 2025 that discuss the implementation of art elements in STEAM learning at various levels of education. The results show that art integration has a significant influence on improving the understanding of geometric concepts, including spatial abilities, visualization of shapes, shape recognition, and modern geometric modeling through artistic activities such as batik motif design, model construction, origami exploration, and the use of visual-based software such as GeoGebra and Surfer. In algebra, art helps strengthen the understanding of patterns, algebraic structures, function graphs, and the representation of variable relationships through a creative visual approach. In addition, art-based STEAM learning has been shown to improve students' creativity, motivation, visual literacy, learning outcomes, and problem-solving abilities in various cultural contexts and authentic projects. These findings confirm that the Art component serves not only as an aesthetic element but also as an effective cognitive tool in deepening conceptual understanding of mathematics. Therefore, art integration in STEAM is recommended as an innovative and relevant learning strategy in developing 21st-century competencies, particularly in geometry and algebra.
Keywords: STEAM, Art Integration, Geometry, Algebra, Visualization, Creativity

Abstrak

Pembelajaran geometri dan aljabar masih menjadi tantangan bagi banyak siswa karena sifatnya yang abstrak dan membutuhkan kemampuan visualisasi serta representasi simbolik yang kuat. Integrasi komponen Art (seni) dalam pendekatan STEAM menawarkan solusi pedagogis yang mampu menjembatani kesenjangan tersebut melalui representasi visual, kreativitas, dan konstruksi makna yang lebih konkret. Penelitian ini merupakan studi literatur sistematis terhadap 20 artikel terbitan 2018–2025 yang membahas implementasi unsur seni dalam pembelajaran STEAM pada berbagai jenjang pendidikan. Hasil penelitian menunjukkan bahwa integrasi seni memberikan pengaruh signifikan terhadap peningkatan pemahaman konsep geometri termasuk kemampuan spasial, visualisasi bangun, pengenalan bentuk, dan pemodelan geometri modern melalui aktivitas artistik seperti desain motif batik, konstruksi model, eksplorasi origami, serta penggunaan perangkat lunak berbasis visual seperti GeoGebra dan Surfer. Pada materi aljabar, seni membantu memperkuat pemahaman pola, struktur aljabar, grafik fungsi, serta representasi hubungan variabel melalui pendekatan visual kreatif. Selain itu, pembelajaran STEAM berbasis seni terbukti meningkatkan kreativitas, motivasi, literasi visual, hasil belajar, serta kemampuan pemecahan masalah siswa dalam berbagai konteks budaya dan proyek autentik. Temuan ini menegaskan bahwa komponen Art tidak hanya berperan sebagai elemen estetika, tetapi sebagai alat kognitif yang efektif dalam memperdalam pemahaman konseptual matematika. Oleh karena itu, integrasi seni dalam STEAM direkomendasikan sebagai strategi pembelajaran inovatif yang relevan dalam mengembangkan kompetensi abad ke-21, terutama dalam pembelajaran geometri dan aljabar.
Kata kunci: STEAM, Art Integration, Geometri, Aljabar, Visualisasi, Kreativitas

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INTRODUCTION

Geometry and algebra are two fundamental domains in the mathematics curriculum, serving as the foundation for abstract thinking, deductive reasoning, and higher-order problem-solving. However, various studies show that these two topics remain a source of conceptual difficulties for the majority of students. In geometry learning, students often experience difficulties visualizing shapes, understanding spatial relations, and interpreting geometric transformations (Daniel et al. 2024). Meanwhile, in algebra, many students experience misconceptions related to the use of variables, symbolic representation, and understanding functional relations (Rodríguez 2022). These difficulties arise because mathematics learning in schools generally emphasizes arithmetic procedures, rather than developing in-depth conceptual understanding.

In this context, the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach emerged as a learning innovation that emphasizes cross-disciplinary integration, including the role of art components in representing abstract concepts. The integration of art into mathematics learning is believed to enrich students' understanding of meaning through visualization, creativity, and design (Kashaka 2024). Art serves not only as an aesthetic activity but also as a pedagogical medium for constructing concrete and visual representations, which are crucial for understanding geometric and algebraic concepts.

In geometry learning, the art component allows students to explore patterns, symmetry, transformations, and spatial structures through drawing, modeling, creating artistic patterns (tessellations), or exploring origami. This visual approach has been shown to improve students' spatial abilities and structural understanding (Arohunmolase 2025). Meanwhile, in algebra learning, art can be used to visualize numerical patterns, variable relationships, function graphs, and other algebraic structures through color representations, illustrations, creative diagrams, and visual animations.

Several studies have shown that art integration in STEAM can reduce math anxiety, increase learning motivation, and deepen students' conceptual understanding by providing a bridge between mathematical abstraction and concrete experiences (Rilianti et al. 2023). This reinforces the finding that incorporating art into the mathematics learning process not

only enhances learning activities but is also an effective pedagogical strategy for overcoming conceptual barriers common in geometry and algebra.

However, existing studies still show several limitations. First, most studies discuss STEAM integration in general without specifically examining the role of the Art component as a cognitive tool in building understanding of mathematical concepts. Second, studies examining art integration in STEAM generally focus on a single material or a specific educational level, thus not providing a comprehensive picture of the contribution of art to the understanding of geometry and algebra concepts across levels. Third, to date, there are still limited systematic literature reviews that synthesize in an integrated manner how art functions as a link between visualization, creativity, multimodal representation, and mathematical abstraction in STEAM learning. These limitations indicate a research gap that needs further study.

Based on these findings, this article aims to present a systematic literature review on the role of art components in enhancing understanding of geometry and algebra in STEAM learning. The focus of this review includes the contribution of art to the visualization of mathematical concepts, the construction of meaning, multimodal representation, and its implications for enhancing conceptual understanding. This literature review is expected to provide an empirical and theoretical foundation for educators, researchers, and curriculum developers in designing more creative, meaningful, and understanding-oriented mathematics learning.

METHODS

This study uses a systematic literature review method to collect, assess, and synthesize research findings related to the role of art components in enhancing understanding of geometry and algebra concepts through STEAM learning. Literature searches were conducted through Google Scholar, DOAJ, and Garuda with publications spanning 2018–2025 to ensure the research's recency and relevance. Keywords used included "Art in STEAM education," "STEAM-based learning," "geometry visualization," "algebra creative representation," "integrated STEAM mathematics learning," "artistic mathematical modeling," and "creative mathematics learning." Articles were selected based on inclusion criteria, namely containing the implementation of art integration in STEAM learning, being available in full-text form, and presenting empirical findings related to

improving understanding of geometry, algebra, creativity, or 21st-century skills. Articles that did not meet the criteria or were not relevant to the focus of the study were excluded.

All articles were analyzed through a data extraction process that included the research identity, the form of art integration used, objectives, methodology, and research results. The data were then reduced and classified into main themes, such as art integration in the visual representation of geometry, the use of artistic activities to understand algebraic structures, the implementation of STEAM-based creative projects, and their impact on creativity, visual literacy, critical thinking skills, and student learning outcomes. The validity of the study was strengthened through source triangulation and a critical review of the methodology of each study. The compilation process was carried out through the stages of topic formulation, determining search keywords, article selection, content analysis, and synthesis of findings to comprehensively describe the effectiveness of the role of the Art component in STEAM learning.

RESULTS AND DISCUSSION

The results of the literature search conducted through academic databases such as Google Scholar, DOAJ, and Garuda regarding the role of art components in improving the understanding of geometry and algebra concepts based on STEAM over the last 8 years (2018-2025) are as follows:

Table 1. Research Literature

Research title	Author/year	Research result
Revitalizing Spatial Geometry Learning through Contextual Collaboration of RME and STEAM	Boedy Irhadtanto, Muhammad Rinov Cuhanazriansyah, and Avita Widya Pratama (2025)	The results of the study indicate that the integration of RME and STEAM can improve students' conceptual understanding, visualization abilities, and critical and creative thinking skills. Furthermore, students demonstrated improvements in learning motivation, mathematical communication, and collaboration and contextual problem-solving skills. These findings indicate that the integration of RME and STEAM is an effective and relevant approach in learning modern mathematics, particularly spatial geometry.
Integration of STEAM	Hanna A. Parhusip,	The results of the study indicate that

in Teaching Modern Geometry Through Batik Motifs Creation with Algebraic Surfaces	Hindriyanto D. Purnomo, and Didit B. Nugroho (2023)	the use of Surfer software to draw algebraic surfaces and convert them into batik motifs can improve students' understanding of modern geometry. Through this activity, students learn to visualize complex geometric objects more concretely while integrating elements of technology and art. The activity of creating batik motifs, whether by copying algebraic surfaces or developing new patterns, also encourages increased creativity, visual representation skills, and innovative skills. Overall, learning that combines Surfer and Batik has proven effective in supporting the STEAM approach and enriching the geometry learning experience.
The Influence of the STEAM Learning Model (Science, Technology, Engineering, Art, and Math) on the Mathematical Representation Ability of Grade VIII Students on Cube and Beam Materials at SMP Negeri 19 Medan	Silva Riska Natalia Simanjuntak, Simon Maruli Panjaitan, and Christina Sitepu (2024)	The results of the study showed that the mathematical representation ability of grade VIII students on cube and beam materials was relatively high with an average score of 45.36. The analysis also revealed a positive relationship between the application of the STEAM learning model and the improvement of students' mathematical representation abilities. In other words, the use of the STEAM approach helps students better describe, model, and explain the concepts of cubes and cuboids mathematically.
GeoGebra and situations that involve modeling anything abordagem STEAM José Manuel Dos Santos	Astrigilda Pires Silveira and Alexandre Emanuel da Silva Trocado (2019)	The results of this study indicate that the use of GeoGebra in two- and three-dimensional geometric modeling tasks effectively supports the implementation of the STEAM approach in mathematics classes. Through various features such as 2D, 3D, CAS, and spreadsheet windows, students can visualize cutting planes, surfaces, and complex geometric objects more clearly. The developed modeling tasks also improve students'

		technological skills, creativity, and analytical and problem-solving abilities. Overall, the application of GeoGebra in a STEAM context strengthens understanding of geometric concepts while creating a more integrative and meaningful learning experience.
Enhancing Geometry Teaching in STEAM Education with Interactive Learning Environments Makpal	Dildabayeva and Lyazzat Zhaydakbayeva (2024)	The results of this study indicate that the use of GeoGebra significantly improved the understanding of geometric concepts in middle school students. Students in the experimental group demonstrated better ability to connect algebraic and graphical representations, especially for trigonometric functions, compared to the control group. In addition to improving conceptual understanding, the use of GeoGebra also positively influenced student engagement and learning performance. Overall, this study confirms that GeoGebra is highly effective in the STEAM curriculum because it enriches the learning experience and supports the development of modern mathematical problem-solving skills.
Analysis of the STEAM Learning Model as a Strategy for Developing Algebraic Numeracy in Junior High Schools	Suhami, Ida Sulistiawati, and Nico Irawan (2024)	The results of this study indicate that the application of the STEAM learning model significantly improved junior high school students' algebraic numeracy. The experimental group learning with the STEAM approach achieved a significantly higher increase in algebraic numeracy scores than the control group using conventional learning. In addition to improving test scores, classroom observations and interviews also revealed that STEAM-based learning can increase students' active participation, learning motivation, and collaborative skills. The integration of various disciplines makes algebra

		material more contextual, engaging, and easier to understand. Despite obstacles such as limited facilities and time, this study concluded that the STEAM learning model is effective in strengthening students' active participation, learning motivation, and collaborative skills understanding of algebra concepts at the junior high school level and is worthy of expanded implementation in schools.
Enriching Mathematics Education with Visual Arts: Effects on Elementary School Students' Ability in Geometry and Visual Arts	Eveline M. Schoevers, Paul P. M. Leseman, and Evelyn H. Kroesbergen (2020)	The results of this study indicate that the MACE (Mathematics, Arts, and Creativity in Education) program is more effective than traditional geometry instruction in improving students' ability to recognize and understand geometric aspects in visual artwork. All students experienced improvements in geometric understanding and creativity, but no significant differences were found between groups in the aspects of explaining geometric phenomena and creative thinking. Therefore, in these aspects, the effectiveness of the MACE program is equivalent to traditional geometry instruction.
Analysis of Students' Mathematical Concept Understanding of Circles Through the Implementation of the STEAM-Based PjBL Learning Model with a Waterwheel Media	Nurwati Djam'an, Nur Hidayah, Melyana Toti, Rustam, and Nur Cahyani Putri Dewi (2025)	The results of this study indicate that STEAM learning through a waterwheel project improves students' understanding of the concept of circles. Art elements are evident when students design the shape of the blades, decorative patterns, and visual design of the waterwheel, making the concept of circles easier to understand creatively and concretely. Students with a high understanding are able to link mathematical concepts with design, while students with a low understanding still have difficulty connecting aesthetics with calculations. Overall, the art-based STEAM project effectively strengthens

		understanding of the concept of circles.
Integration of STEAM in Mathematics Learning to Enhance Creativity and Innovation	Bariyah and Lia Hamimi (2025)	The results of this study indicate that the integration of the STEAM approach in geometry learning has a significant effect on increasing students' creativity and innovation. Based on the results of the Wilcoxon test, a significance value of 0.000 (<0.05) was obtained, indicating a significant difference between creativity scores before and after the treatment. Students' post-test scores consistently improved compared to pre-test scores. Thus, the implementation of STEAM has proven effective in encouraging students to think more creatively, generate new ideas, and develop innovative solutions in the context of mathematics learning.
Innovations in STEAM-Based Early Childhood Mathematics Learning Using Loose Parts to Build 21st-Century Competencies	Atiasih (2025)	The results of this study indicate that the loose parts-based STEAM approach effectively helps children understand basic mathematical concepts while developing creativity, critical thinking, communication, and collaboration. Exploratory activities with loose parts make learning more meaningful and developmentally appropriate. In addition to improving learning quality, this approach also supports spiritual character formation and contributes to the preparation of the golden generation of 2045.
Understanding of Science, Technology, Engineering, Art, and Mathematics (STEAM) in Preschool Teacher Candidates	Avanti Vera Risti Pramudyani and Toni Kus Indratno (2022)	The results of this study indicate that students have a very good understanding of the elements of Science, Engineering, and Art, especially in designing creative loose parts-based activities that support early childhood exploration and problem-solving. However, understanding of the Technology and Mathematics elements is still less than

		optimal, as indicated by limitations in integrating simple technology and applying mathematical concepts appropriately. Overall, prospective teachers are quite ready to implement STEAM, but still need reinforcement in these two elements.
Understanding of Geometry Concepts in Early Childhood Learning	Naili Sa'ida (2021)	The results of the study indicate that STEAM-based learning is effective in developing understanding of geometry concepts in early childhood. Based on data analysis using the Wilcoxon Matched Pairs Test, the obtained values of Tt = 0 and Tt = 3 at a 5% significance level with N = 10. Because Tt ≤ Tt, there is a significant difference between the scores before and after the treatment, indicating that STEAM-based learning is proven to improve children's understanding of geometry concepts. Improvements were seen in all indicators, namely the ability to group geometric shapes by color, shape, and size, as well as the ability to name surrounding objects that have geometric shapes. Furthermore, STEAM makes children more active, engaged, and enthusiastic when exploring various activities that combine elements of science, technology, engineering, art, and mathematics. Thus, innovative STEAM-based learning models significantly contribute to strengthening geometry understanding in early childhood.
Integrating STEAM into the PjBL Learning Model to Improve Students' Spatial Abilities in Material Geometry	Bagus Surya Maulana, Leilita Shiva Elfitria and Laili Maftukhah (2022)	The results of the study show that PjBL-STEAM can increase motivation and creativity in Mathematics learning, thereby improving spatial abilities. The PjBL model, when integrated into STEAM, is a perfect combination of students' cognitive abilities in understanding the material and teachers' abilities in implementing PjBL-STEAM in the classroom. PjBL-

		STEAM will produce students who have skills or thinking and can face the challenges of the 21st century and the Industrial Revolution 4.0. This article can be useful to provide knowledge about PjBL-based STEAM learning on the material to readers.
Networking Between Ethnomathematics, STEAM Education, and the Globalized Approach to Analyze Mathematical Connections in Daily Practices	Camilo Andrés Rodríguez-Nieto and Ángel Alsina (2022)	The results of this study indicate that the craftspeople's activities contain geometric concepts (shape, size, symmetry) and algebraic concepts (patterns and proportions) that emerge naturally in cultural practices. Through the integration of Ethnomathematics and STEAM, particularly the Art element, these concepts are interconnected and not isolated. Three findings emerged: intradisciplinary connections in mathematics, interdisciplinary connections in accordance with STEAM principles, and the relationship between cultural mathematics and school mathematics. The study confirms that this approach makes learning geometry and algebra more contextual and meaningful.
Improving Understanding of Geometric Structures through an Ethno-STEAM Approach in Second-Grade Elementary School Students	Sri Rahayu, Vicky Dwi Wicaksono, and Satrio Budiyanto (2024)	The results of the study showed that the implementation of Ethno-STEAM learning improved geometry learning outcomes and student creativity. Learning implementation reached 87% in cycle I and 80% in cycle II, which is considered very good. The average student learning score increased to 90, with an increase (N-Gain) of 81%, indicating high effectiveness. Furthermore, student responses to Ethno-STEAM learning were also very positive, at 84.4% in cycle I and 88.1% in cycle II. Overall, Ethno-STEAM learning proved effective in improving understanding of geometry concepts while enhancing student creativity.
Development of an E-	Aulia Rahma Tambusai and	The results showed that, with a

Module Based on the STEAM (Science, Technology, Engineering, Art, and Mathematics) Approach for Rectangles and Triangles	Fibri Rakhmawati (2025)	maximum scale of 4.00, the media validation score was 3.73, the material validation score was 3.70, and the language validation score was 3.73. This indicates that the digital module can be used in a very practical manner. The average practicality percentage of the digital module was 81.31%, indicating it was very practical. Furthermore, the STEAM-based digital module was deemed quite effective, with an N-Gain value of 0.5651 for the effectiveness test. Therefore, the developed digital module can be considered useful and effective for teaching rectangles and triangles.
Improving Creativity in Algebraic Concepts in Grade VII Students	Dini Aulia and Rika Handayani (2024)	The results showed that the use of GeoGebra software can improve students' creative thinking skills in algebraic shapes. The average pre-test score for students was 43.70, with a normal distribution, indicating that their initial abilities were still low. After being exposed to GeoGebra-based learning, the average post-test score increased to 62.90 and remained normally distributed. This improvement indicates that visualizing and manipulating algebraic objects through GeoGebra helped students better understand concepts, resulting in significant development in their creative thinking skills in solving math problems.
Developing engaging STEAM-geometry activities: Fostering mathematical creativity through the engineering design process using the Indonesian cuisine context	Agnita Siska Pramasdyahsari, Maya Rini Rubowo, Velma Nindita, and Iin Dwi Astutik (2024)	The results of this study indicate that STEAM-based geometry activities with the Engineering Design Process (EDP) can enhance students' mathematical creativity. Through the Wingko Babat design project, students were able to apply geometric concepts in a cultural context, generate creative ideas, and solve design challenges more innovatively. Expert validation determined that the developed

		activities were valid and feasible for use. Overall, STEAM-based learning is effective in enhancing students' creativity, understanding of geometric concepts, and problem-solving skills.
Implementation of Project-Based STEAM Learning to Improve Elementary School Students' Understanding and Creativity in Mathematics	Arvita Indah Wulandari, Siti Maisaroh, and Qurrotul Aini (2025)	The results of this study indicate an increase Significant improvements in student learning outcomes, with the average grade increasing from 47.65 to 77.61, and learning completion increasing from 0% to 86.96%. In addition to cognitive improvements, affective and psychomotor development, such as creativity, cooperation, and enthusiasm, were also observed. These findings demonstrate that project-based STEAM learning is effective in improving conceptual understanding and 21st-century skills in elementary school students.
Development of Student Worksheets (LKPD) on Geometry Material Based on Jambi Culture to Enhance Student Creativity	Ayu Wandari, Kamid, and Maison (2018)	The results of the study indicate that the Jambi culture-based mathematics worksheets developed using the ADDIE model are of good quality and suitable for use. Validation by material experts and design experts stated that the product is highly suitable for geometry learning. Furthermore, the gain test result of 0.7 indicates an increase in students' mathematical representation abilities in the high category. Questionnaire analysis also showed that more than 80% of students responded positively to the use of the worksheets. Overall, this worksheet is not only effective in improving understanding of geometry, but is also able to encourage students' creativity in solving mathematical problems.

Based on the analysis of several articles, STEAM learning that integrates art components has been shown to significantly contribute to improving the understanding of geometry and algebraic concepts. To avoid a purely descriptive discussion, the research

findings are grouped into several main themes: (1) art for geometric visualization, (2) art for algebraic representation, (3) ethnomathematics connections through art, and (4) developing creativity and 21st-century skills.

1. Art as a Means of Visualizing Geometric Concepts

Most of the studies summarized in the table indicate that art integration in STEAM learning contributes significantly to improving students' visualization skills and spatial understanding of geometry. Research by Irhadtanto et al. (2025), Simanjuntak et al. (2024), Maulana et al. (2022), and Rahayu et al. (2024) reports that design activities, model construction, and artistic visualization help students understand spatial relations, the properties of geometric shapes, and geometric transformations more meaningfully.

Furthermore, the use of visual technology-based media such as GeoGebra and Surfer (Dos Santos et al., 2019; Parhusip et al., 2023) strengthens the role of art in supporting the geometric visualization process. Through visual exploration and artistic motif design, students can manipulate two- and three-dimensional geometric objects, making abstract concepts more concrete and easier to understand. In this context, art functions as a visual-cognitive aid that supports the formation of comprehensive geometric mental representations.

Therefore, art plays a crucial role as a visualization tool in STEAM-based geometry learning because it can strengthen students' spatial abilities, relational understanding, and the construction of meaning regarding complex geometric concepts.

2. Art in the Representation and Understanding of Algebraic Concepts

The findings in the research table also indicate that art plays a significant role in helping students understand symbolic and abstract algebraic concepts. Research by Suhami et al. (2024) and Simanjuntak et al. (2024), and Dini Aulia and Handayani (2024) showed that arts-based STEAM learning can improve students' algebraic numeracy, mathematical representation skills, and creativity.

Creative visual representations such as patterns, colored graphs, and manipulation of algebraic objects through visual software help students connect algebraic symbols with their conceptual meaning. With the support of arts, students are encouraged to see algebra as patterns and relationships between variables, not simply symbol manipulation procedures.

Therefore, art serves as a link between concrete experiences and symbolic representations in algebra learning.

Thus, the integration of arts in STEAM-based algebra learning helps strengthen conceptual understanding, reduce symbolic misconceptions, and enhance students' algebraic representation skills and creativity.

3. Ethnomathematic Connections through Arts in STEAM Learning

Another important theme emerging from the study findings is the role of arts in connecting mathematics learning with cultural contexts through an ethnomathematics approach. Research by Rodríguez-Nieto and Alsina (2022), Parhusip et al. (2023), and Rahayu et al. (2024) showed that traditional arts activities such as batik, handicrafts, and culinary design incorporate authentic geometric and algebraic concepts, including patterns, symmetry, and proportion.

The integration of culture-based arts makes mathematics learning more contextual and relevant to students' lives. Art serves as a contextual link that bridges formal mathematics in schools with everyday cultural practices. Through this approach, students not only understand mathematical concepts more meaningfully but also build connections between academic knowledge and their socio-cultural environment.

Thus, art in the context of ethnomathematics acts as a bridge between formal mathematics and local culture, strengthening conceptual understanding while increasing student relevance and engagement in learning.

4. Developing Creativity and 21st-Century Skills

Almost all of the studies summarized in the table report that arts-based STEAM learning has a positive impact on the development of creativity and 21st-century skills. Research by Bariyah and Hamimi (2025), Pramasdyahsari et al. (2024), and Wulandari et al. (2025) shows that project-based and design-based activities encourage students to think creatively, collaborate, and solve problems innovatively.

At the early childhood and elementary school levels, research by Atiasih (2025), Naili Sa'ida (2021), and Wandari et al. (2018) shows that art helps students build an initial understanding of geometric concepts while developing communication, collaboration, and

creativity skills. Art activities such as the use of loose parts and visual design enable learning that aligns with students' cognitive developmental stages.

Therefore, the integration of arts in STEAM learning contributes significantly to the development of mathematical creativity and 21st-century skills, supporting holistic and future-oriented mathematics learning.

Overall, the literature review demonstrates the crucial role of art in STEAM learning, not only in supporting the visualization of geometric concepts and algebraic representations, but also in connecting mathematics to cultural contexts and fostering creativity and higher-order thinking skills. Thus, art is not merely a supporting element in STEAM, but rather a strategic component that directly contributes to deepening understanding of mathematical concepts.

CONCLUSION

Based on the synthesis of the discussion, it can be concluded that the Art component plays a central role in enhancing the understanding of geometry and algebra concepts in STEAM learning. Art helps students build strong visual representations, connect mathematics with cultural contexts, and develop creativity and problem-solving skills. Various studies have shown that when art elements are systematically integrated into mathematics learning, there is a significant increase in students' visualization abilities, mathematical representations, conceptual understanding, and creativity at all levels of education. Therefore, art is not only a complement to STEAM, but is a key component that can deepen mathematics learning conceptually, visually, and creatively. The integration of art in STEAM is recommended as an effective approach to support mathematics learning in the modern era that demands creative literacy and higher-order thinking skills.

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