

Conference Proceedings

CIVAE 2026

8th Interdisciplinary and Virtual Conference on Arts in Education

March 18- 19, 2026

Edited by MusicoGuia

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Geometry Learning with Pattern Blocks: Spatial Reasoning in Art Education at secondary school level

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Abstract

An educational innovation experience in art education was conducted in the classroom of a secondary school using pattern blocks as teaching material. The proposal follows an interdisciplinary approach integrating mathematical and artistic content, situating the learning of plane isometries as the basis for creating geometric and visual compositions. The intervention was implemented as a practical workshop in which students, through guided activities, progressively developed the capacity to apply geometric transformations in the plane. The methodology linked semi-regular tessellations with artistic compositions, supporting the development of spatial reasoning. This experience acts as a motivational agent for converting the art classroom into an active mathematical learning environment. Results indicate an increase of student engagement, persistence in tasks resolution, and improvement in spatial visualization skills in geometric contexts highlighting the potential of combining manipulation of teaching material in interdisciplinary learning processes within compulsory curricula.

Keywords: Spatial Reasoning, Pattern Blocks, Secondary Education, Art Education, Geometry.

Aprendizaje geométrico con *pattern blocks*: razonamiento espacial en Educación Artística a un nivel de Educación Secundaria

Resumen

Se presenta una experiencia de innovación en educación artística llevada a cabo en el aula de una escuela de Educación Secundaria Obligatoria mediante el uso de *pattern blocks* como recurso manipulativo. Esta propuesta multidisciplinaria integra contenidos matemáticos y artísticos, situando el aprendizaje de las isometrías en el plano como base para la creación de composiciones geométricas y visuales. La intervención se desarrolló como un taller práctico en el que el alumnado, mediante actividades guiadas, desarrolló progresivamente la capacidad de aplicar transformaciones geométricas en el plano. La metodología vincula teselaciones semi-regulares con composiciones artísticas, favoreciendo el desarrollo del razonamiento espacial. Esta experiencia actúa como agente motivador para convertir el aula de plástica en un entorno de aprendizaje matemático activo. Los resultados sugieren una mayor implicación del alumnado en la resolución de tareas y mejora en las habilidades de visualización espacial en contextos geométricos. Destaca el potencial que tiene la combinación de materiales manipulativos en los procesos de aprendizaje interdisciplinario dentro de los currículos obligatorios.

Palabras clave: Razonamiento espacial, Pattern blocks, Educación Secundaria, Educación Artística, Geometría.

Introduction

In secondary education curricula, subjects are often separated into disciplinary fields, hindering integrated competence acquisition. Geometry is commonly taught through memorized constructions, while art education emphasizes creative expression without fully addressing the mathematical structure underlying visual images. Nevertheless, both domains share concepts supporting interdisciplinary approaches (Gerdes, 1999).

Geometric understanding depends on spatial reasoning and skills to recognize and transform elements in the plane and space, therefore, visualization and experimentation are essential, as well as isometries since they involve movement, shape preservation, and spatial relationships (Gutiérrez, 2005).

Active learning strategies (Vale & Barbosa, 2023) increase engagement through challenge-based learning and generates direct feedback, encouraging participation and persistence. Hence, linking geometry with artistic creation through mosaics and tessellations can provide support to visual comprehension of geometric objects, while manipulative materials connect action with abstraction. Based on this framework, this study analyses an educational innovation experience with third-year secondary school students. A dynamic workshop using pattern blocks addresses geometric transformations as a tool for artistic creation to foster spatial reasoning and active participation.

Spatial Reasoning and Artistic Geometry

Since the last two decades, several studies have demonstrated that the incorporation of tessellations in educational contexts enhances motivation and creativity for the learning processes at all academic levels (Ward, 2003; Revelo & Bedoya, 2025; Uribe et al., 2014). Furthermore, it is a fact that integration of visual arts into the mathematics curriculum is already being implemented in several countries as it favours an increase in academic performance (Nutov, 2021; Santos, 2024).

Active learning promotes participation, persistence in the face of difficulty, and cognitive involvement, particularly in practical learning environments reorganizing the educational experience through challenges, progression, feedback, and decision-making and positioning students as active participants in knowledge construction.

The learning of geometry is closely related to the development of spatial reasoning, understood as the ability to recognize, represent, and transform shapes in the plane and in space (Battista et al., 1982). This involves constructing mental images and understanding spatial relationships essential for mathematical reasoning (Clements & Sarama, 2009). Consequently, geometry teaching becomes more meaningful when supported by manipulative and perceptual experiences linking action and abstraction.

Geometric transformations such as translation, rotation, and reflection constitute a fundamental component in geometric reasoning. Their application in mosaics and tessellations links mathematics with artistic creation, thus turning mathematics into a visual language shared by art and science. In this context, manipulative materials facilitate the understanding of abstract concepts through direct interaction (Bruner, 1966). Pattern blocks are especially effective for exploring geometric relationships, constructing tessellations, and experimenting with plane transformations, supporting the transition from concrete experience to symbolic representation and promoting interdisciplinary learning across mathematics and art education (Riera et al., 2015).

Methodology

The study follows a qualitative descriptive-interpretative approach. The objective focuses on analysing the active learning process generated after implementing a teaching proposal. Accordingly, the methodology is based on systematic classroom observation and analysis of students' productions as evidence of learning.

The intervention was conducted during the first term of the 2025/2026 academic year in four groups of 3rd year Compulsory Secondary Education at a secondary school in the province of Cádiz (Spain). The intervention was integrated into the teaching program of the subject Visual and Audio-visual Arts Education. No prior selection of participants was conducted, and the activity took place in a real teaching-learning context.

The groups presented heterogeneous learning levels, allowing analysis of the inclusive potential of active learning methodology and its capacity to facilitate the understanding of geometric concepts through visual creation.

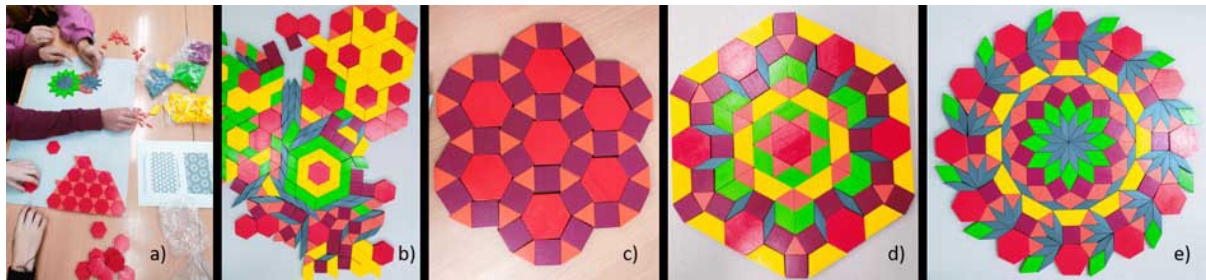
The intervention consisted of an interactive workshop based on the use of pattern blocks for learning geometric transformations in the plane. The proposal was organized into sequenced sessions combining manipulative exploration, progressive challenge solving, and artistic creation.

For the analysis of the experience, qualitative instruments were used, including direct observation, photographic records of the work processes, and students' final productions. These sources of evidence made it possible to analyze the spatial reasoning and student engagement. The analysis was conducted through qualitative categorization of the collected evidence, focusing on two dimensions: the development of spatial reasoning and participation in an active learning. Source triangulation allowed interpretation of the impact of the proposal on interdisciplinary learning between mathematics and art education.

Results and Discussion

The analysis of the intervention, based on systematic classroom observation, students' final productions and photographic records, revealed changes in both the spatial organization of the compositions and student engagement during the activity. The manipulation of pattern blocks promoted a progressive structuring of the productions. While trial and error predominated initially, later stages showed prior planning and anticipation of results. Students began grouping pieces according to congruence, continuity, and modular repetition, identifying axes and directions of the semi-regular tessellation growth. This evolution indicates a transition from a global perception of figures to a relational understanding of geometric structures associated with the development of spatial reasoning. This process corresponds to progression in which experimentation precedes formal conceptualization.

At the same time, the active learning modified students' participation compared with previous lecture-based sessions. Increased sustained attention, persistence in the face of difficulty, and autonomy in solving challenges were observed. We confirmed this tendency: students highlighted the possibility of testing solutions until achieving a satisfactory result, interpreting error as part of the learning process. These behaviours align with approaches describing active learning as a reorganization of learning based on challenges and continuous feedback, promoting task persistence and decision-making. Overall, the combination of manipulation of pattern blocks simultaneously enhanced student engagement and spatial reasoning, establishing a bridge between artistic experience and geometric organization. Figure 1 summarises the active learning and some works made by students during the workshop.



Note. a) Active learning in the classroom. b) Free experimentation. c) Semi-regular tessellation. d) Hexagonal composition. e) Circular composition.

Figure 1. *Razonamiento espacial con pattern blocks*, C. Heredia-Martínez y A. Colín, 2025.

Conclusions

The implemented experience shows that incorporating active learning strategies in Secondary Education promotes more active and sustained student participation in learning geometry. Reorganizing the activity around challenges and experimentation encouraged persistent engagement in solving spatial problems.

The use of pattern blocks facilitated the understanding of isometries by allowing direct observation and manipulation, supporting the progressive construction of geometric meanings prior to formalization. The integration of mathematics and Art Education also helped interpret plane transformations as visual phenomena, reinforcing conceptual understanding.

From a didactic perspective, the results indicate that active learning combined with manipulative materials and an interdisciplinary approach, suggest potential as a teaching strategy for addressing abstract content in compulsory educational contexts. The proposal increases student engagement and strengthens the relationship between perception, action, and conceptualization.

As a future line of work, the experience could be extended to other educational levels and its continuity analysed in terms of transferring geometric knowledge to new learning contexts. In this context, artistic creation functions as a mediating learning environment rather than a directly evaluated variable.

Acknowledgments

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