



TOOLS, MATERIALS, AND TECHNIQUES USED IN THE 3D REPRESENTATION OF THE IDEAL CITY

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ABSTRACT

The present study investigates the tools, materials, and techniques used by students in the 3D representation of the ideal city. It analyzes the effectiveness of this practical approach in fostering creativity, critical thinking, and spatial representation skills. The research also aims to highlight the formative potential of scale-model construction activities as an active, student-centered teaching method, emphasizing that hands-on modeling and construction activities lead to sensory learning, active engagement, and critical thinking. To achieve the research objectives, 79 students aged 16–17 from three 10th-grade classes at the “Al. Papiu Ilarian” National College in Târgu Mureș were involved in a project-based learning activity. The students were divided into groups of four or five and engaged in several stages of the project; this paper focuses in particular on aspects related to the stage of constructing scale models of the ideal city (three-dimensional or 3D representations). The research adopts a qualitative approach with quantitative elements. The analysis of the scale models revealed a wide variety of tools, materials, and techniques used by the students, as well as a high level of engagement and creative expressiveness. The results indicate that project-based learning is an effective instructional method with strong formative potential, contributing to the development of students’ creative, practical, and cognitive competencies.

Keywords: 3D representation, scale model, ideal city, practical skills, spatial thinking, critical thinking, creativity

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INTRODUCTION AND THEORETICAL FRAMEWORK

Since Antiquity, cities have experienced natural development, with the urban fabric maintaining a division into “urban blocks” delineated by streets. With industrialization (second half of the 18th century – 19th century), certain imbalances emerged, such as pollution, inadequate street networks, and unhealthy working-class neighborhoods. Major urban interventions became necessary, exemplified by the transformations carried out in Paris during the first part of the second half of the 19th century under the direction of Georges Haussmann, including the urban penetrations created by the new boulevards (Benevolo, 2003).

The “Functionalist City,” whose principles were outlined in the Athens Charter of 1933 (Le Corbusier, 1946), represents the model of the city created by modern (open) urbanism, addressing in a radical way the problems of existing cities. Modern urbanism abandons the traditional city, with the functionalist city being



constructed “from scratch.” Among the principles of the functionalist city are the division of the city into separate functional zones (functional segregation between housing, workplaces, and leisure areas), the abandonment of the traditional “urban block” in favor of freely positioned buildings (“breaking the urban block”), the separation of circulation modes in the city (prioritizing motor vehicles over pedestrians), and vertically developed housing blocks benefiting from abundant fresh air and natural light (Rowe & Koetter, 1978). In the second half of the 20th century, modern urbanism faced numerous critiques (Rowe & Koetter, 1978) due to the social and urban problems it generated. Nevertheless, modern urbanism continues into contemporary times through favorable concepts such as vertical city development, building orientation, and solar exposure.

New Urbanism represents one of the contemporary directions in built environment planning (Kelbaugh, 2007), aiming to recover the values and qualities specific to the traditional city. Among its fundamental principles, as detailed in the Charter of the New Urbanism (Leccese & McCormick, 1999), are: the compact city, mixed-use city, mixed-use buildings, hierarchical organization of the built environment (urban transect), the concept of the “15-minute city” (Gehl, 2010), the reduction of the urban heat island effect (Kelbaugh, 2019), and the promotion of pedestrian mobility in urban spaces (Conțiu & Conțiu, 2026).

In Romanian pre-university education, in recent decades, relatively little attention has been given to the study of geography in general (Conțiu & Conțiu, 2025b), and to urban geography and the development of practical skills in particular, as evidenced by the national curriculum frameworks and geography syllabi for high school (Ministry of Education and Research, 2004, 2006) and lower secondary school (Ministry of National Education, 2017). Nevertheless, on the one hand, the study of urban geography aims to develop students’ and pupils’ capacity to identify (Dulamă, 1996; Conțiu & Conțiu, 2025b), analyze (Dulamă & Sanislai, 2016), and evaluate (Sosna et al., 2025) solutions for urban space planning (Dulamă, 2010b) and for problems specific to the urban environment (Dulamă, 2010a), to design urban spaces that ensure adequate living conditions for inhabitants, and to make forecasts (Filip, 2009; Filip & Ursu, 2018; Ilovan et al., 2016, 2018a, 2018b; Meenar et al., 2022). On the other hand, the development of geography-specific competencies involves the use of tools, materials, and techniques specific to 3D representations.

One of the most effective ways to stimulate creativity (Albulescu, 2009; Setiawan et al., 2018), spatial thinking (Zhang, 2019; Ursu et al., 2019), critical thinking (Dulamă, 2004a, 2004b, 2007, 2008c; Paul & Elder, 2006; Widana et al., 2018; Yuliati & Lestari, 2018; Singh & Marappan, 2020), and cooperative learning (Pop-Păcurar, 2007; Dulamă, 2008b; Pop-Păcurar et al., 2023) is through the development of projects dedicated to ideal cities or the planning of innovative urban spaces (Dulamă et al., 2012, 2013; Conțiu & Conțiu, 2023, 2024, 2025b, 2026). By expressing and harnessing their creative potential, students reconfigure familiar elements in an original manner and develop skills for generating new ideas (Cropley, 2001; Lucas & Spencer, 2021). The mental (cf. Kitchin, 1994; Miclea, 1999; Johns & Blake, 2001; Drăgan et al., 2025), graphic (two-dimensional), and spatial (three-dimensional) construction of an ideal city requires geography-specific competencies developed over time through repeated exercises (Conțiu & Conțiu, 2025a) and supports the development of geographical thinking oriented toward a sustainable economy (Conțiu & Conțiu, 2025b).

The construction of scale models is recognized in the specialized literature as a valued form of experiential learning (Ionescu & Bocoș, 2017; Harris et al., 2025) that motivates students to engage actively in the learning process (Dulamă, 2008a; Dulamă & Roșcovan, 2007) and to develop essential spatial representation and conceptualization skills (Delpont & Morkel, 2011; Ilovan, 2024). Pedagogical studies emphasize that model-making (the creation of physical scale models) facilitates the process of generating, visualizing, and evaluating design ideas by transforming abstract concepts into manipulable concrete objects (Delpont & Morkel, 2011; Afify et al., 2021), allowing students to test proportions, relationships, and solutions within a real three-dimensional framework. Research in design contexts indicates that physical models serve as cognitive tools that support reflection on projects (Glava, 2003; Glava & Glava, 2005) and reveal the evolution of ideas throughout the creative process, contributing to a deeper understanding of the subject matter and to the development of students’ critical and creative thinking (Facione, 2015; Halpern, 2014).

Experiential learning-based teaching approaches (Kolb, 1984; Kolb & Kolb, 2017), which involve the use of traditional materials (paper, cardboard, wood, polystyrene, or other construction materials) and techniques such as cutting, gluing, assembling, and finishing (Pöllänen, 2019a, 2019b), accompanied by



explanatory texts (Dulamă et al., 2008d; Magdaş, 2018; Conțiu & Conțiu, 2025a), offer significant pedagogical benefits. The literature (Afify et al., 2021; Yi et al., 2025) indicates that the use of physical models in the learning process reduces cognitive load, as students can directly manipulate three-dimensional components and observe the effects of modifications on the structure, which enhances information retention and understanding of complex spatial relationships. Physical modeling, scale model construction, and working with traditional materials support the development of students' practical and cognitive skills (Newman et al., 2018), including comprehension of three-dimensional forms, active engagement in projects, and the connection between theory and the tangible outcome of a 3D representation (scale models). Furthermore, these hands-on activities promote kinesthetic (sensory) learning, which involves multiple senses, thereby increasing engagement and the quality of learning—a pedagogical strategy supported by constructivist theories that describe learning as an active, contextualized, and student-centered process (Dulamă, 2008a; Newman et al., 2018; Harris et al., 2025).

This research was initiated based on the observation that students experience difficulties in practically applying what they learn theoretically in geography lessons and beyond (Conțiu & Conțiu, 2023), in representing urban space in 2D (Conțiu & Conțiu, 2025b) and 3D (Conțiu & Conțiu, 2026), and rarely engage in kinesthetic (sensory) learning. The aim of this study is to investigate how students use tools, materials, and techniques for the 3D representation of the ideal city, as well as to analyze the effectiveness of this hands-on approach in developing creativity, critical thinking, and spatial representation skills. The study also seeks to highlight the formative potential of scale model construction activities as an active, student-centered teaching method, emphasizing that hands-on modeling and construction activities lead to sensory learning, active engagement, and critical thinking.

The present research aligns with our ongoing efforts to identify practical ways to enhance students' understanding and the quality of their representations of geographic space (Dulamă et al., 2012; Mândruț, 2012; Mândruț & Ardelean, 2012; Conțiu & Conțiu, 2025b), particularly through active engagement that involves object manipulation, action, and direct experience. Students construct scale models not merely as an exercise in following instructions (learning by doing; cf. Kirschner et al., 2006), but, above all, they conceive, experiment, and make decisions regarding the tools, materials, techniques used, and aesthetic aspects (learning by making; cf. Halverson & Sheridan, 2014). At the same time, they reflect on the process of knowledge construction, not only on the final product (cf. van Dijk et al., 2020). Thus, both the creative process generated by the task of 3D representation of the ideal city and its impact on spatial thinking and the development of practical skills can be highlighted. This study continues a series of previous high school-level investigations (Dulamă et al., 2012, 2013; Conțiu & Conțiu, 2023, 2024, 2025a, 2025b, 2026). To achieve the study's aim, two research questions were formulated:

Q1. What tools, materials, and techniques do students use for the 3D representation of the ideal city, and how do these contribute to the development of spatial thinking and creativity?

Q2. What stages do students follow in designing and constructing the scale model, and how do they organize the work process to transform their ideas into concrete three-dimensional representations?

METHODOLOGY

Participants

The research involved 79 10th-grade students from the "Al. Papiu Ilarian" National College in Târgu Mureș and was conducted during the 2023-2024 school year. Classes were selected based on profile and specialization: two classes followed a science profile, with specializations in "Intensive English Natural Sciences" (GE^A) and "Intensive Computer Science Mathematics" (GE^B), and one class followed a humanities profile, with a specialization in "Intensive German Social Sciences" (GE^C). Students were grouped into teams of 4 or 5, homogeneous in age (16-17 years) but heterogeneous in gender and in geography and practical skills: five teams of five students in class A (GE^A), six teams of five students in class B (GE^B), and six teams of four students in class C (GE^C). The same classes and teams were involved in previous studies (Conțiu & Conțiu, 2023, 2024, 2025b, 2026).



Procedure

Students were engaged in a project-based learning activity. They were assigned, in groups, the task of completing the project titled: Representation of the Plan and Scale Model of the Ideal City Based on a Given Reality (the medieval fortress of Târgu Mureș and its surroundings) (Conțiu & Conțiu, 2023, 2024, 2025b, 2026). Activities were organized and carried out both during Geography lessons and outside class. Students went through four stages, as outlined in previous studies by Conțiu & Conțiu: (1) the documentation stage (November-December 2023) (Conțiu & Conțiu, 2023); (2) the fieldwork stage (January-February 2024) (Conțiu & Conțiu, 2024); (3) the stage of developing the plans of the ideal city/ 2D representations (March-April 2024) (Conțiu & Conțiu, 2025b); and (4) the stage of constructing the scale models of the ideal city/ 3D representations (May 2025) (Conțiu & Conțiu, 2026).

Teaching Activities

In the present study, we analyze the tools, materials, and techniques used by students for the 3D representation of the ideal city, a stage carried out in May 2024 and detailed in a previous study (Conțiu & Conțiu, 2026). Three sub-stages were completed during this phase.

Sub-stage 1. Discussion of the Task and Objectives. Students were presented with the task of creating, in groups, a scale model of the ideal city using various tools, materials, and techniques, after having previously conducted research, carried out fieldwork, and developed the plan of the ideal city.

The task was formulated as follows: Form teams of 4 or 5 students. Each team will create a scale model of an ideal city (on an A2-sized base/support, based on the plan developed in the previous stage) in the form of a 3D representation, using a variety of *tools* (colored pencils, felt-tip pens, markers, scissors, rulers, cutters, glue guns, etc.), *natural materials* of either plant origin (dried twigs, seeds, pressed and dried plants, dried flowers and fruits, etc.) or animal origin (eggshells, feathers, shells, etc.), along with various rocks and minerals, *artificial materials* (polystyrene, wood-based materials such as particle board, MDF, wooden sticks, paper – crepe, colored –, cardboard, ceramic materials, modeling clay, Lego pieces, textiles, adhesives – glue, paste, silicone –, watercolors, acrylic paints, etc.), and *work techniques* (gluing, assembling, cutting, trimming, folding, painting, collage, modeling, “Papier-mâché”, “Origami”, “Quilling”, etc.). Students were also instructed to write a short text describing the tools, materials, and techniques used in designing and constructing the scale model, as well as the stages followed.

Students were expected to achieve the following objectives in this activity: the three-dimensional (3D) representation of the ideal city using a variety of tools, materials, and techniques; and the presentation of the stages followed in designing and constructing the scale model.

Sub-stage 2. Team Formation and Group Construction of the Ideal City Scale Model. Students formed the teams as follows: five teams of five students in class A (GE^A); six teams of five students in class B (GE^B); and six teams of four students in class C (GE^C). Each team organized its activities, distributed tasks, and designed and constructed the scale model of the ideal city both during Geography lessons and outside class, in accordance with the requirements set by the teacher.

Sub-stage 3. Presentation of Results. Teams prepared a short text in which they presented the tools, materials, and techniques used in the representation of the ideal city in the form of a scale model, as well as the stages followed. The research results were discussed with the teacher and the other teams during a Geography lesson. The scale models of the ideal city were evaluated by the teacher and by another team selected by the teacher.

Instrument

Research data were collected using an evaluation grid for the scale models of the ideal city, which included four categories of tools, materials, and techniques used in their construction: graphic tools, cutting and gluing tools, natural materials of plant and animal origin along with rocks and minerals, artificial materials, and work techniques (Table 1).



Analysis of Written Texts

The written texts regarding the construction of the ideal city scale models, prepared by the students, were analyzed based on two criteria: the tools, materials, and techniques used to create the scale model, and the presentation of the stages followed in designing and constructing the model (Table 2).

RESULTS

a) Evaluation of students' 3D representations using the assessment rubric, from the perspective of the tools, materials, and techniques employed

A comparative analysis of the 17 models created by students (which were the subject of a previous study, Conțiu & Conțiu, 2026; Plate 1) highlighted, in general, directions for sustainable development: the need to assert local identity and develop the economy based on local resources, the ecological and restrictive role of agro-forestry strips in limiting urban expansion, alternative energy sources and green cities, the importance of interurban connections, and so on (cf. Magnaghi, 2014; Poli, 2015). Unsustainable development trends were also noted, such as uncontrolled territorial expansion, low building density, and functional segregation. All groups identified problems characteristic of contemporary cities – such as the lack of local facilities, deficient infrastructure, urban heat islands, and insufficient green spaces – which they attempted to address (cf. Conțiu & Conțiu, 2026).

Plate 1

Students' 3D representations of the ideal city (models)



1. Târgu Cetății (Group 1, GE^A)



2. Nuvon (Group 2, GE^A)



3. Civitas Marisiensis (Group 3, GE^A)



4. Terra Nova-E (Group 4, GE^A)



5. Veridis (Group 5, GE^A)



6. Orașul Melania (Group 1, GE^B)



7. Phoenix (Group 2, GE^B)



8. Hestia (Group 3, GE^B)



9. Viridis (Group 4, GE^B)



10. Solatina pe Mures (Group 5, GE^B)



11. Bolyaiburg (Group 6, GE^B)



12. Sallrano Civitas (Group 1, GE^C)



13. Novapolis (Group 2, GE^C)



14. Green City (Group 3, GE^C)



15. Lavco Citta (Group 4, GE^C)



16. Terra Green (Group 5, GE^C)



17. Greenhood (Group 6, GE^C)

(Source – Conțiu & Conțiu, 2026)

Table 1 presents the tools, materials, and techniques used by each team in creating models of the ideal city. The students' representations were evaluated by the two teachers using an assessment rubric, which was exhaustively detailed in a previous study by Conțiu & Conțiu (2026), and the results were discussed with the students during a geography lesson.

All teams used graphic, cutting, and gluing tools. Four teams (23.5%) employed natural plant-based materials (leaves, twigs, etc.). Artificial materials were preferred by all teams, with varying proportions. Almost all teams (16 teams; 94.1%) used polystyrene, paper, and cardboard, while 11 teams (64.7%) used wooden materials (wooden sticks). Eight teams (47.1%) used Lego pieces and modeling clay. As for working techniques, all teams opted for cutting, gluing, and assembly techniques; nine teams (52.9%) used painting techniques; eight teams (47.1%) applied modeling techniques; and seven teams (41.2%) used collage techniques, alongside other techniques such as papier-mâché, origami, and quilling (cf. Conțiu & Conțiu, 2026).

Table 1

Assessment rubric for the tools, materials, and techniques used in creating models of the ideal city

Group/ Group number		GE ^A (Class A)					GE ^B (Class B)						GE ^C (Class C)						Total	
		1	2	3	4	5	1	2	3	4	5	6	1	2	3	4	5	6	Nr.	%
Tools	Graphic tools	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	17	100
	Cutting and gluing tools	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	17	100
Natural materials	Plant-based materials	-	-	-	-	-	-	x	x	-	-	-	-	-	-	x	x	-	4	23,5
	Animal-based materials	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	Rocks and minerals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
Artificial materials	Polystyrene	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	16	94,1
	Wooden materials	-	x	x	-	x	x	x	x	-	-	-	x	x	x	x	x	-	11	64,7
	Paper and cardboard	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	16	94,1
	Lego pieces	-	x	-	-	-	-	-	-	x	x	x	x	x	-	-	x	x	8	47,1
	Modeling clay	-	-	-	x	-	x	-	-	-	x	x	x	-	x	x	-	x	8	47,1
Working techniques	Cutting, gluing, and assembly techniques	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	17	100
	Painting techniques	x	-	-	-	-	x	-	-	x	x	x	x	-	-	x	x	x	9	52,9
	Collage	-	-	x	-	-	x	-	-	x	-	-	x	-	x	x	-	x	7	41,2
	Modeling	-	-	x	x	-	x	-	-	-	x	-	x	-	x	x	-	x	8	47,1
	Other techniques: „Papier-mâché”, „Origami”, „Quilling”, etc.	-	-	x	-	x	x	-	x	-	-	-	x	x	-	x	-	-	7	41,2
Total	No.	6	7	9	7	7	11	7	8	7	9	7	12	8	9	12	9	10	145	
	%	40,0	46,7	60,0	46,7	46,7	73,3	46,7	53,3	46,7	60,0	46,7	80,0	53,3	60,0	80,0	60,0	66,7		56,9

(Source – adapted from Conțiu & Conțiu, 2026)



b) Analysis of the written texts associated with students' models of the ideal city

Most teams specified the tools they used to create their models (13 teams; 76.5%). In general, the teams employed graphic tools (graphite pencils, colored pencils, markers, felt-tip pens, brushes) as well as cutting and gluing tools (cutters, scissors, hot glue guns).

Sixteen teams (94.1%) specified the materials they used to create their models. The majority of teams (15; 88.2%) used polystyrene for the base of the model, with the exception of two teams that used cardboard or newspaper sheets glued with PVA glue. For representing the street network, teams used paper or cardboard, or they drew the network on paper, crepe paper, or a cardboard support. Buildings were made from various materials, including polystyrene, paper, cardboard, wooden sticks, modeling clay, Lego pieces, and Monopoly pieces, with teams demonstrating creativity in selecting materials with specific characteristics (color, shape, texture, etc.) to represent certain types of buildings. Some teams represented the given reality (the urban space considered) suggestively, using materials such as wooden sticks, cardboard, modeling clay, or Lego pieces of specific colors, while other teams paid less attention to emphasizing this, creating difficulties in "reading" the model. Trees were also created from diverse materials, including polystyrene, crepe paper, modeling clay, Lego pieces, leaves, artificial flowers, artificial moss, wooden sticks, and metal pins. Some teams chose materials for trees that were compatible with those used for other elements of the model, whereas others selected materials that caused confusion in interpreting the model. Rivers and lakes were represented using paper, crepe paper, cardboard, modeling clay, slime, Lego pieces, or were drawn on the paper/crepe paper/cardboard support. Certain teams proved inventive in selecting and combining materials to convey specific ideas related to urban planning and sustainability.

Eleven teams (64.7%) specified the techniques they used to create their models. The majority of teams employed cutting, gluing, assembly, painting, and modeling techniques. A small number of teams (3; 17.6%) used techniques such as collage, "papier-mâché", "origami", and "quilling".

Twelve teams (70.6%) presented the steps followed in designing their models. Most teams did not provide sufficient detail on the model design stage, highlighting the difficulty they faced in developing a systematic and precise 3D model. A small number of teams, particularly those from Class C, described this stage carefully.

Eleven teams (64.7%) presented the steps followed in creating their models. Among these, the vast majority described these steps in detail, demonstrating the students' interest in expressing their own visions of urban planning and sustainability in three dimensions, using a variety of tools, materials, and techniques. Notably, some stages were often omitted, such as recording identification data on the model and performing self-evaluation of the produced outcome.

Table 2

Analysis of the written texts accompanying students' models of the ideal city.

<i>Criteria</i> <i>Group number</i>	Tools, materials, and techniques used in model construction	Presentation of the steps followed in designing and constructing the model
	GE^A (Class A)	
1	<ul style="list-style-type: none"> - colored pencils, scissors, cutters; - polystyrene for representing the base of the model and the buildings; - crepe paper for representing the river in the city; - tracing paper for transcribing the street network from the ideal city plan; - cardboard for representing the street network and agricultural land; - did not specify the techniques used. 	<ul style="list-style-type: none"> - the stages followed in designing the model: 1, research at the County Library and the College Library; 2, online discussions and group brainstorming to establish the characteristics of the ideal city; 3, determining the scale using Google Maps, delimiting the given reality, and locating the Mureş River; 4, calculating the energy needed to supply apartment blocks with solar energy to represent a land area with appropriately sized photovoltaic panels; representing the ideal city plan. - the stages followed in constructing the model: 1, creating the model base from polystyrene and shaping the relief to scale; 2, coloring the model base; 3, representing the watercourse; 4, copying the street network from the plan onto the model using tracing paper; 5, cutting out the streets and gluing them onto the model; 6, cutting buildings from polystyrene (to scale, according to the plan), coloring them, and attaching them to the model.



2	<ul style="list-style-type: none"> - polystyrene; matchsticks for representing the city fortress; Lego and Monopoly pieces for representing houses; metal pins; - the tools and techniques used were not specified. 	<ul style="list-style-type: none"> - the stages followed in designing the scale model: 1, research on urban planning, sustainability, and the modern city; 2, sketching the street network and the functional zones of the ideal city on an A4 sheet of paper; 3, representing the plan of the ideal city; - no explanations were provided regarding the stages followed in the construction of the scale model.
3	<ul style="list-style-type: none"> - cutters and scissors for cutting polystyrene, crepe paper, and cardboard; - wooden sticks for representing the medieval fortress and its surroundings (the given reality); cardboard for representing agricultural land and forests; crepe paper for representing the hydrographic artery; colored modeling clay for representing buildings and trees; string; - modeling; "origami" (airplane making). 	<ul style="list-style-type: none"> - no explanations were provided regarding the stages followed in designing the scale model; - the stages followed in the construction of the scale model: 1, creating the city's relief by cutting the polystyrene; 2, covering the base of the model with crepe paper; 3, modeling the buildings from modeling clay and fixing them onto the model using wooden sticks; 4, making airplanes using the "origami" technique.
4	<ul style="list-style-type: none"> - the tools, materials, and techniques used were not specified. 	<ul style="list-style-type: none"> - the stages followed in designing the scale model: 1, the team members' documentation on the ideal city (the history of urban planning, urban facilities, functional zones of cities, alternative energy sources); 2, representing the plan of the ideal city (aimed at creating a "balanced city"); - no explanations were provided regarding the stages followed in the construction of the scale model.
5	<ul style="list-style-type: none"> - polystyrene for representing the base of the scale model; paper, cardboard; wooden sticks for representing the fortress, the railway, and tree trunks; crepe paper for representing trees; - the tools and techniques used were not specified. 	<ul style="list-style-type: none"> - the stages followed in designing the scale model: 1, research (types of cities, sustainable cities, "smart cities"); 2, sketching the functional zones of the ideal city on paper; 3, sketching the street network; 4, representing the plan of the ideal city; - no explanations were provided regarding the stages followed in the construction of the scale model.
GE^B (Class B)		
1	<ul style="list-style-type: none"> - brushes, scissors, glue gun; - board used as the base of the scale model, providing stability and support for all components; layers of newspaper soaked in white glue creating a solid and lightweight base; watercolors; white glue used as the main adhesive to fix the parts of the scale model; modeling clay used for shaping the components of the scale model; varnish; - cutting, gluing, assembling, painting, varnishing, modeling, "papier-mâché". 	<ul style="list-style-type: none"> - no explanations were provided regarding the stages followed in designing the scale model; - the stages followed in representing the scale model: 1, creating the basic structure using newspapers and white glue (cutting the newspapers into strips and soaking them in white glue diluted with a little water; subsequently, applying these strips onto the base board to shape the main form of the model – "papier-mâché" technique); 2, modeling with modeling clay (after the base structure had dried and hardened, the details of the model were shaped using modeling clay; students modeled various elements: buildings, trees, landforms, etc.); modeling clay is a flexible material that allows for fine details and can be easily adjusted during the modeling process; 3, assembling and gluing the elements (after modeling the clay elements, they were attached to the base structure using the glue gun and white glue – the glue gun was essential for fixing larger or heavier elements, providing quick and secure adhesion; white glue was used for smaller elements or areas requiring more precise adhesion); 4, adding color (using watercolors, they added color and details to the model; thin layers of watercolor were applied to create natural shades and highlight details, rendering shadow and light effects); 5, finalizing and securing (in the final stage, the model was reviewed to add the last details and secure all elements; after the paint had dried, a thin layer of transparent varnish was applied to protect the surface and provide a glossy or matte finish, as appropriate). - the construction of this scale model involved the creative use of various materials and techniques, from modeling with clay and building the base structure from newspapers, to detailing and painting with watercolors.



		Each step was essential to achieve a detailed and harmonious final result, accurately representing the intended concept.
2	<ul style="list-style-type: none"> - markers; scissors; - polystyrene for creating the base of the scale model; green crepe paper; gray cardboard; colored paper; wooden toothpicks; artificial moss; glue; - cutting and folding techniques. 	<ul style="list-style-type: none"> - the stages followed in designing the scale model: 1, central placement of the reference urban area (the given reality) on the plan of the ideal city; 2, adding residential areas, two high schools, and a primary school on the plan of the ideal city; 3, adding a leisure complex, industrial zones, and wind turbines on the plan of the ideal city; - the stages followed in representing the scale model: 1, creating a polystyrene base covered with green crepe paper to represent the surrounding areas of the city, according to the plan; 2, delineating the city using gray cardboard sheets, based on the plan; 3, tracing the streets using markers; 4, constructing the buildings from sheets of different colors (yellow, residential buildings; red, schools; pink, industrial buildings; light green, leisure buildings; dark green, parks; orange, administrative buildings); 5, creating trees from artificial moss and toothpicks, and constructing wind turbines from toothpicks.
3	<ul style="list-style-type: none"> - polystyrene; crepe paper; cardboard; wooden sticks; wooden toothpicks; white glue; adhesive tape; double-sided tape; metal pins; lichens; artificial flowers; - the tools and techniques used were not specified. 	<ul style="list-style-type: none"> - no explanations were provided regarding the stages followed in designing and constructing the scale model; - they only mentioned that, for the construction of the ideal city scale model, they used the plan previously created.
4	<ul style="list-style-type: none"> - brushes, watercolors, colored markers; cutters, glue; - polystyrene board; wooden cubes; Lego pieces; - cutting, gluing of wooden/ Lego/ polystyrene pieces, painting, sketching of areas of the ideal city. 	- no explanations were provided regarding the stages followed in the design and creation of the model.
5	<ul style="list-style-type: none"> - colored pencils, pens; - polystyrene; cardboard; A2 and A4 paper; glue; play dough; Monopoly piece houses; Monopoly piece cars; - cutting and gluing techniques; modeling. 	<ul style="list-style-type: none"> - the stages followed in designing the model: 1, studying existing cities (Sibiu, Buzău, Frankfurt, Padua, Istanbul); 2, planning the ideal city (no information was provided regarding how the planning was carried out); 3, using the program <i>Paintool.sai</i> to process the satellite image of the reference urban area (the given reality); 4, transferring the reference reality from the computer screen onto paper; 5, attaching the sheet of paper depicting the medieval fortress and its surroundings at the center of an A2 sheet; 6, representing the plan of the ideal city; - the stages followed in representing the model: 1, creating the topography of the ideal city by cutting the polystyrene and reinforcing it with a cardboard base; 2, attaching the plan onto the polystyrene; 3, making the houses from Monopoly pieces and other buildings from modeling clay; clusters of cars made from Monopoly pieces suggest the presence of parking areas.
6	<ul style="list-style-type: none"> - pencils for drawing streets; - A2 sheet for creating the base of the model; cardboard; glue; Lego pieces; elements from the Monopoly game; metal elements; 3D-printed pieces for constructing the mall and the hospital; - cutting and gluing techniques; 	<ul style="list-style-type: none"> - no explanations were provided regarding the stages followed in designing the model; - stages followed in representing the model: 1, drawing the streets and green spaces with pencils; 2, gluing with adhesive the residential blocks, houses, and schools made from cardboard, Lego, and Monopoly pieces; 3, 3D-printing pieces to represent the hospital and the mall.
GE^C (Class C)		
1	<ul style="list-style-type: none"> - pencils; brushes; glue gun; - polystyrene for the model base; polystyrene balls of various sizes (for representing hills); crepe paper; cardboard of different sizes and thicknesses; newspaper; two small boxes; tempera paint; brushes; silicone refills for the glue gun; toothpicks; Monopoly pieces for houses; 	<ul style="list-style-type: none"> - the stages followed in designing the model: 1, choosing the name of the ideal city through brainstorming; 2, establishing a radial-concentric plan type; 3, delimiting the "given reality" on a map obtained from <i>Visit Mureș</i> (following a field application coordinated by the teaching staff); 4, sketching the "given reality" on the plan (centrally positioned); 5, drawing the streets, the Mureș River, and the buildings, and coloring the plan; 6, documenting the conventional elements, naming the streets, and creating the corresponding legend; - the stages followed in constructing the model: 1, selecting and acquiring materials; 2, gluing crepe paper onto the polystyrene, tracing the streets



	<ul style="list-style-type: none"> - cutting, gluing, assembling, and painting techniques. 	<p>with a pencil, cutting cardboard pieces in the shape of the streets, and gluing them onto the model; 3, painting Monopoly pieces in the chosen colors to represent different types of buildings, wrapping the purchased boxes in newspaper and painting them to represent the zoo and the airport; 4, cutting out and painting the lake, helipads, and parking areas; 5, delimiting the fortress using toothpicks glued together and painted; 6, creating the tree trunks from painted wooden toothpicks and their crowns from crepe paper; 7, attaching all components to the model using the plan previously created.</p>
2	<ul style="list-style-type: none"> - colored pencils, markers, glue gun; ▣ polystyrene, colored paper, crepe paper, cardboard, wooden sticks, Lego pieces; - cutting, gluing, assembling techniques, <i>Origami</i>. 	<ul style="list-style-type: none"> - the stages followed in designing the model: 1, team members' documentation regarding the ideal city (books and articles); 2, sketching on the plan the "given reality," contour lines, new streets, and facilities (no information was provided regarding how the plan design was carried out); 3, reinforcing the lines and coloring the plan; 4, creating the legend, indicating the scale, and showing the north orientation; - the stages followed in constructing the model: 1, creating the base from polystyrene and covering it with paper; 2, constructing buildings from Lego pieces and attaching them to the model; 3, representing the streets; 4, representing the trees.
3	<ul style="list-style-type: none"> - pencils, markers, scissors; - polystyrene, cardboard of various sizes, toothpicks, modeling clay, metal pins; - the techniques used were not specified. 	<ul style="list-style-type: none"> - the stages followed in designing the model: 1, each team member's documentation regarding the ideal city; 2, sketching ideas and group discussions related to different scenarios for city planning (goal: integrating the "given reality" and incorporating natural and built elements into the ideal city); 3, creating the first plan of the ideal city (on an A3 sheet using graphite and colored pencils; it was unsatisfactory as they noticed certain important details regarding the topography and structure of the given reality were omitted); 4, creating the second plan of the ideal city (they learned from previous mistakes and managed to balance natural and built elements, ensuring better coherence); - no explanations were provided regarding the stages followed in constructing the model.
4	<ul style="list-style-type: none"> - markers, scissors, cutters; - polystyrene, crepe paper, paint, double-sided tape, wooden skewers, modeling clay, slime, artificial flowers; - cutting, gluing, painting, modeling. 	<ul style="list-style-type: none"> - the stages followed in designing the model: 1, documentation (on urbanism, history of urbanism, city typologies, urban facilities, green spaces, and their arrangement); 2, brainstorming within the group and transcribing the ideas expressed into a sketch regarding the design of the ideal city; 3, coloring the plan of the ideal city and adding details; - the stages followed in constructing the model: 1, creating the model base from polystyrene and attaching crepe paper onto it; 2, tracing the streets according to the ideal city plan; 3, cutting shapes from polystyrene to represent buildings, then painting them; 4, fixing the buildings onto the model using wooden skewers; 5, creating details from modeling clay; 6, shaping slime to represent water; 7, attaching the details to the model; 8, placing the label with identification information on the model.
5	<ul style="list-style-type: none"> - graphite pencils, colored pencils, markers, glue gun; - polystyrene, paper, crepe paper of various colors, cardboard, wooden sticks, Monopoly pieces; - cutting, gluing, painting techniques. 	<ul style="list-style-type: none"> - the stages followed in designing the model: 1, delimiting the "given reality" (following a field application coordinated by the teaching staff); 2, documentation (history of urbanism, urban settlements, types of cities, urban architecture, concept of the "green city"); 3, creating a sketch to establish the placement of the "given reality" and the positioning of functional zones; 4, distributing tasks within the group; each group member representing a functional zone on the plan using pencils and markers; 5, selecting conventional symbols and creating the legend; - the stages followed in constructing the model: 1, creating the base from polystyrene and covering it with crepe paper; 2, making residential blocks from polystyrene through cutting, painting, and attaching them to the model; 3, representing houses with green Monopoly pieces and commercial facilities with red Monopoly pieces; 4, creating the street network from paper and bridges from wooden sticks.
6	<ul style="list-style-type: none"> - colored pencils, scissors, cutters; - polystyrene, crepe paper, modeling clay, Lego pieces, metal pins, glue; - cutting, gluing, painting techniques. 	<ul style="list-style-type: none"> - the stages followed in designing the model: 1, marking the outline of the "given reality" and the buildings it includes, using a map of Târgu-Mureș (following a field application coordinated by the teaching staff); 2, documentation (urbanism, history of urbanism, types of cities); 3, representing the ideal city around the "given reality;"



		- the stages followed in constructing the model: 1, creating the base from polystyrene and covering it with green crepe paper; 2, cutting the streets from paper and attaching them to the model using metal pins; 3, constructing buildings from Lego pieces and attaching them to the model; 4, creating houses, the river, lakes, and the forest from modeling clay.
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DISCUSSION AND CONCLUSIONS

The activity of three-dimensional representation of the ideal city facilitated the development of essential cognitive processes, such as spatial thinking, critical thinking, and creativity, which are closely linked to art education and the formation of students' transversal competencies. Spatial thinking, defined as the ability to perceive, manipulate, and mentally represent the relationships between objects in space (Uttal et al., 2013; Delpont & Morkel, 2011), played a central role in creating three-dimensional constructions. Students practiced understanding volume, proportion, and perspective, as well as the relationships between plane, height, and depth – fundamental skills in 3D representation and visual education. By integrating these cognitive processes, the activity contributed to the development of active, reflective, and creative learning, in which the student becomes a conscious participant in the construction of their own knowledge.

The models of ideal cities created by students highlight their representations of the city in which they currently live, as well as their aspirations for a version closer to the ideal (Conțiu & Conțiu, 2026). Analysis of the models revealed a variety of tools, materials, and manual techniques used by the students, as well as a high level of engagement and creative expressiveness. All teams used graphic tools such as colored pencils, markers, and brushes, as well as cutting and gluing tools, including scissors, cutters, and glue guns. Artificial materials were preferred, with polystyrene and paper used in almost all models, while natural, plant-based materials were employed by only a few teams. For representing certain elements of the model and various types of urban facilities, some teams opted for Lego pieces, which made their work easier, although proportions were not fully respected. Others preferred to wrap boxes of different sizes with paper, which required more effort; however, proportions were also only partially maintained, and the functionality of buildings and spaces was not always clear. The most frequently used techniques were cutting, gluing, and assembling, followed by painting and modeling, while special techniques such as "papier-mâché", "Origami", or "Quilling" were employed sporadically. The results indicate that creating models (3D representations of urban space) represents an effective teaching method with high formative potential, contributing to the development of students' creative, practical, and cognitive competencies.

Analysis of the models also highlights that the educational intervention had a differentiated impact on the development of the targeted competencies. Compared to the initial stages of the activity, there is an observed increase in students' ability to organize three-dimensional space and assign clear functions to urban elements, even though specific difficulties related to spatial thinking persist. Certain spatial thinking challenges can be observed, such as excessive crowding, lack of a clear hierarchy of buildings, or spatial organization resembling dispersed rural settlements. Additionally, the representation of the street network is, in many cases, schematic or implicit, indicating the need for supplementary educational interventions focused on urban planning.

Analysis of the texts produced by the students showed that the majority of them detailed the materials and techniques used, highlighting their creativity and the ability to select materials according to the characteristics of the objects being represented, such as buildings, green spaces, or infrastructural elements.

Regarding the stages followed by students in designing and constructing the model, it was found that the process begins with documentation on the ideal city and the reference urban space, continues with planning and sketching the city plan, followed by selecting and preparing materials, building the model base, and then creating the three-dimensional elements. Completion of the model includes decorating, coloring, detailing, and securing the components, sometimes accompanied by adding the label with identification information. Teams that carefully followed these stages produced coherent and complex final products, demonstrating that adhering to a structured work process is essential for the efficiency of practical activities.



A comparative analysis of the stages followed in designing and constructing the model and the final product (the ideal city model) indicates that careful adherence to work stages in the educational activity “guarantees” a complex and coherent final product (the model).

Critical thinking, defined as the ability to analyze, evaluate, and formulate reasoned judgments in relation to a given situation or problem (Facione, 1990, 2015; Alkhatib, 2019), was stimulated through decision-making related to the organization of urban space, the functionality of buildings, and their relationship to community needs. Students were encouraged to compare solutions, justify their choices, and reflect on their impact within the urban ensemble. Understood as a form of evaluative thinking, critical thinking was manifested to the extent that students reflected, both orally and in writing, on their own spatial organization decisions. Following discussions and model presentations, some students identified inconsistencies in building placement, disproportionate ratios between built and open spaces, or difficulties in representing urban functionality, recognizing both successful aspects and problematic elements of their own work.

Creativity, understood as the ability to generate original and valuable ideas through the flexible combination of prior knowledge and experiences (Guilford, 1950; Sosna et al., 2025), was evident in the design of imaginative architectural structures, in the reinterpretation of urban elements, and in the expressive use of materials. The creative process was supported by freedom of expression and the open nature of the assigned task. Students’ creativity was predominantly manifested at the expressive and formal level, through the use of color, volume, materials, tools, and diverse techniques. However, analysis of the models indicates that the functional dimension of creativity, specific to urban and architectural design, is insufficiently developed. Many of the proposed solutions are imaginative and visually appealing, yet difficult to realize in actual practice, highlighting the need for progressively orienting activities toward project-based thinking.

In conclusion, in response to the research questions, it can be stated that students use a diverse combination of graphic tools, cutting and gluing tools, various artificial materials, and occasionally natural materials in creating their models, applying multiple techniques that not only facilitate the concrete manipulation of elements but also contribute to the development of practical skills, spatial thinking, and creativity. This diversity of resources and techniques allows students to explore multiple representation solutions, experiment with different material combinations, and test their ideas in a visual and tangible manner, thereby reinforcing learning through experience (Q1).

Regarding the stages of model construction, students follow a complex process that begins with researching the topic and analyzing the urban space, continues with detailed planning and project sketching, selecting and preparing materials, and the actual construction of three-dimensional elements, and concludes with finishing and detailing the model. Organizing work in groups, collaborating, and dividing tasks allows for the transformation of abstract ideas into coherent and well-structured representations, while simultaneously developing skills in planning, coordination, and problem-solving (Q2).

The results of the activity confirm that the three-dimensional representation of the ideal city constitutes an effective educational tool for diagnosing and stimulating creativity, critical thinking, and spatial reasoning. At the same time, students’ products highlight the current limitations of these competencies, emphasizing the essential role of pedagogical guidance and didactic progression in moving from intuitive expression to functional urban thinking. Thus, model-making proves to be an active and effective student-centered teaching method that fosters sensory engagement and the consolidation of practical skills, while also bridging theoretical and practical knowledge (three-dimensional representation of urban space), allowing students to directly experience the principles of urban design and the organization of the built environment.

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