3d Modeling Methodology for the Creation of Paper Toys for Educational Purposes using 3D Modeling Software

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Abstract: - Technological progress has resulted in a growing boom of applications that have left aside the art of folding, cutting, molding, or gluing physical materials that allow the development of motor skills and strengthen imagination, creativity, and recursion. This research proposes a structured methodology of three phases: pre-production, production, and post-production, which, through 3D modeling techniques, the use of various software such as Autodesk Maya and Adobe Substance Painter, and the support of other technological tools, allows the creation of paper toys of characters inspired by the narrative cultural manifestations of Riobamba, Ecuador. The results were evaluated through the analysis of 15 variables to assess the 3D modeling for its subsequent construction on paper. The proposed methodology, combined with the analysis of coding, proved to be effective in the creation of precise templates for any character, architecture, or object, thus facilitating the design and manufacture of paper toys for their application as educational material to promote the cultural manifestations of the region.

Key-Words: - Architecture, Culture, Design, Toys, Maya, Modelling, Paper, Three-dimensional.

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1 Introduction

Building 3D models from paper can be a simple process when templates with the necessary parts are available. It is only necessary to cut, fold, and glue the parts, using the flaps, which are additional sections that facilitate the assembly of the final object. On the web, there are many collections of paper templates for making 3D figures of objects, animals, and geometric characters. However, it can be difficult to find templates that represent specific characters from stories, legends, or movies with details of clothing and characteristic elements. Therefore, it is essential to propose a methodology that allows the creation of templates of any 3D geometric character, object, or scenery for subsequent assembly on paper, [1], [2].

1.1 Rationale and Literature Review

Paper Toy

They are three-dimensional figures made of paper that are constructed by assembling previously cut and folded pieces. This art has its roots in origami, a traditional Japanese paper-folding technique, although some historians point out that its origin goes back to Chinese practices that, as they expanded, were adopted and transformed by the Japanese to create more complex and artistic figures, [3]. In the early days, the stencils to create these toys featured manually designed graphics, adding details such as color and shape. Today, paper toy graphics have evolved, and there are digital models available online that can be printed, as well as blank templates that can be downloaded and customized, [4].

Paper craft

It is an artistic discipline focused on the creation of characters or objects in three dimensions based on paper. This technique requires skill and precision when carving, folding, and fitting the paper in order to achieve elaborate and complicated figures, [5]. They are based on the idea that paper, for artisans a very accessible and flexible resource that can be easily converted into an artistic work through innovative and creative processes. Thanks to this practice, creators and designers discover different expressive possibilities by experimenting with different textures, tones, and shapes [6], which is used in a wide variety of fields such as graphic design, interior design, architectural modeling, staging of events and exhibitions, production of

cards and personalized gifts, among others. In addition, it has become widespread in the world of entertainment, such as the recreation of characters for video games, TV series, and movies through paper figures. On the other hand, papercraft is a creative and affordable way to practice crafts with both children and adults. This technique allows creating all kinds of figures or structures with cardboard or any type of paper, in three dimensions, cutting and gluing different parts of the material to assemble them and thus assemble the piece or figure, [7].

Fitting

It is the reduction to simple shapes, almost always geometric, of the complex structures that contain or structure the models we want to represent. For this purpose, it is common to make "a box" or reduce objects to basic shapes such as the cylinder, sphere, or cube, which serve as a reference to better understand their structure and proportions, [8]. For every example, it's important to recognize that any feature present, be it a figure or an item in the surroundings, can be broken down into basic geometric forms, [9].

Cultural manifestations

They are based on the expressions and feelings that reflect the cultural, social identity, and values of a certain place, which are transmitted from generation to generation. The cultural features can be of different natures, like material, immaterial, spiritual, affective, and intellectual characteristics, which distinguish each society or social group. Cultural identity, on the other hand, represents the set of values, beliefs, and behaviors of a given group, giving a sense of belonging to its population, [10]. In the same way, cultural manifestations are present in people's daily lives, constituting the symbol of memories that are transmitted from one generation to another and are the source of inspiration to create paper toys inspired by characters of popular culture, [11].

Narrative manifestations

These are forms of expression used to tell stories through different media, such as writing, film, television, theater, music, and dance, among others. These narrative manifestations admit diverse forms and styles, which are used to communicate experiences, emotions, ideas, and messages to an audience. Each of the narrative manifestations has its own particularities and its own distinctive elements that make it a special and unique phenomenon, bringing life and meaning to the compositions.

Modeling

It is a technology for developing a three-dimensional object, represented mathematically, through specialized software that is essentially based on the possibility of generating a three-dimensional image, modifying it, reformulating it, and adapting it, in an appropriate computer environment, creating digital models, [12]. 3D modeling is a fundamental tool for creating character-inspired paper toys because it makes it possible to create a detailed and realistic design of the figures before converting them to paper. This technique makes it possible to design more accurate characters in terms of shape and proportion, since it is possible to add complex details and textures to the characters, making them more attractive and realistic, [13]. The advantage of 3D modeling for the manufacture of paper toys is the ease with which designs can be visualized and edited before printing them on paper. This speeds up the manufacturing process, as the design can be corrected and adjusted more quickly and simply, [14].

Box modeling

Also known as box modeling, this is a technique used in 3D modeling that basically consists of representing the three dimensions of the objects to be created by means of simple shapes (cubes, spheres, cylinders, cones, etc.). Then, these basic parts can also be transformed, merged, or adjusted to obtain a more detailed and complex modeling, [15]. All 3D models are made up of polygons, which in turn are made up of vertices and edges. Vertices are the points that indicate the location within the dimensions (x, y, z), and edges are the lines that join these points, thus constituting the polygons that generate a 3D object, [16]. Nowadays, polygons have become the basis of many 3D models and are widely used in the development of content such as animated effects, movies, video games, and more applications on the Internet.

Technology for 3D modeling development

In recent years, the annual growth of the 3D modeling and design market has been 21.7%. According to estimates, it will reach a value of more than $11 billion worldwide by 2025, [17]. Also, according to a report by Digital Printing, the 3D printing market in the architecture and construction sector is estimated to experience growth from $0.17 billion in 2019 to $1.7 billion in 2024,

demonstrating the increased interest in the use of 3D technology in such fields, [18].

An analysis conducted by IDC forecasts that $28 billion of investment in software and applications related to 3D technology on a global scale will be reached by 2022, demonstrating the importance that this technology is gaining in different sectors, [19]. This technology makes possible the accurate visualization of products before proceeding to their manufacture, allowing the optimization of processes and providing new alternatives to meet the challenges currently faced in various industrial sectors, [20].

Autodesk Maya

It is an all-in-one software that serves for the different stages of modeling, although it undoubtedly stands out above others in the sections of UV mapping, retopology, rigging, simulations, and, especially, in animation. Moreover, through its own programming language (MEL) or Python, it is possible to create scripts to increase its versatility even more, [21]. For many, it is one of the best 3D modeling programs due to its great versatility and powerful tools. Among its main features are: an Intuitive interface, a large variety of tools, high-quality rendering, and Flexible customization, [22].

The objective of this research was to propose the creation of a 3D modeling methodology for the creation of paper toys that seeks to provide teachers and people in general with a tool that not only allows them to create templates, but also to obtain 3D digital modeling with geometric styling, keeping the representative aesthetics of each of the characters.

2 Materials and Methods

The methodological proposal consists of creating paper toys inspired by mythological characters of Ecuador as an original and creative way to disseminate and keep alive the oral tradition and cultural heritage of the country. These paper toys could be designed with details that reflect the essence and personality of each character, allowing children and adults to connect playfully and educationally with the richness of Ecuadorian mythology.

Exploratory research was utilized, aiming to examine a subject comprehensively to gain deeper insights. To create 3D models of the paper toys representing Ecuador's narrative cultural expressions, a qualitative method was implemented to gather vital information for developing the optimal solution. For conducting this study, both an observation form and a technical sheet served as instruments, with the observation form focusing on gathering and documenting details about each character from the legends (Table 1).

Table 1. Characteristic data record of the personages

CODE	
FIGURE SHEET	
Legend:	*(Name of legend)*
Personage:	*(Name of the personage)*
Period of Legend Development:	*(date)*
Description *(Description of the figure):*	
Text analysis *(main and secondary idea)*	**Graphic analysis** *(Color, size, shape, texture)*
Illustrated image *Image*	
Clothing: *(description of the character's clothing)*	**Personality:** *(Description of the character's personality)*

Source: created by the authors

A qualitative approach and use of observation and technical sheets for data collection were used, especially in the context of capturing cultural attributes and ensuring accurate representation of the mythological characters.

The technical data sheet made it possible to detail the chromatics and materials to be used in the texturing of the main characters of the legends of Riobamba (Table 2).

Table 2. A record of technical data that will identify the characters

CODE	
UV mapping and material data sheet	
Legend:	*(Name of legend)*
Personage:	*(Name of the personage)*
Chromatomy *(Color in RGB)*	**Materials** *(Character's costume)*
UV Maps *(Parts of the character that can be mapped)*	**Texturing** *(Texturing process)*

Source: created by the authors

The cards compiled information on the six main characters of the six legends of Riobamba, which are: La silla en el cementerio, El Descabezado, Magdalena Dávalos, El Luterano, Kulta Kucha, and El Chuzalongo, helping to accurately determine the graphic style, personality, and clothing of each character, and the technical card

allowed detailing the chromatics and materials to be used in the texturing of the characters.

The proposed methodology is composed of the following phases, shown in Figure 1, highlighting the importance of the Box Modeling and Uves subphases, since an adequate development in these stages guarantees the accuracy of the construction templates.

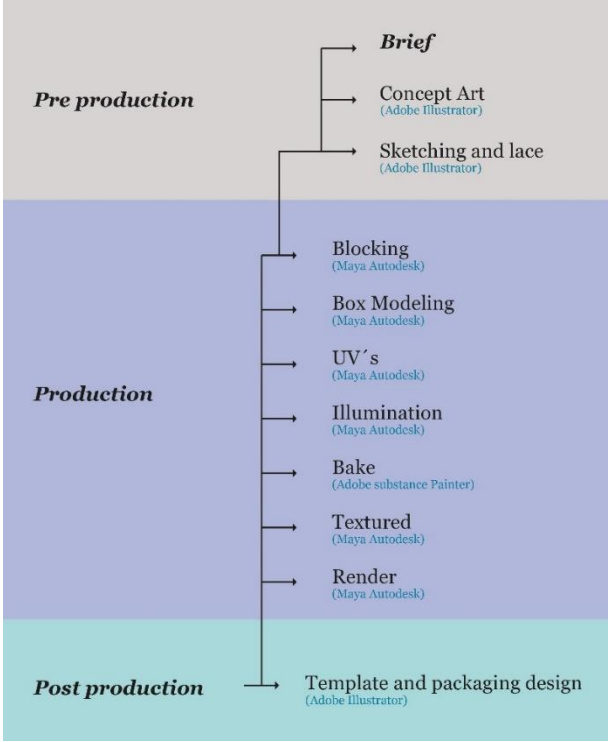

Fig. 1: Phases of the proposed methodology applying the 3D process
Source: created by the authors

The proposed methodology details the work process, structured in three sections corresponding to the phases of pre-production, production, and post-production, each of which has specific characteristics:

2.1 Pre-production Phase

Firstly, this phase aims to establish a geometrized illustration style from the most organic illustration style that has been used for the creation of the illustrations of each reference character, and also, this phase determines the chromatics and visual references that are necessary to start the 3D modeling process. The phase has the following sub-phases:

Brief

Based on the information gathered and recorded in each file, we proceed to the construction of the brief, which is the clear idea that allows the designer to generate ideas to create a sketch, with characteristics according to the client's needs and the objective of the project to achieve a quality final product. The briefing or briefing is an essential tool for the approach of a project, since it specifies both the problem to be solved and the proposed objectives. It is the first step to start the project, since it offers a clearly structured guide for its realization. Specifically in the case of 3D modeling of paper models of Ecuador's narrative cultural manifestations, the briefing will be the basis for achieving the proposed objectives.

Table 3 (Appendix) shows the brief developed for the project, an Illustration of Riobamba Legends as a strategy to strengthen the identity of the children of Riobamba Canton. We proceed to the development of the following stages.

Artistic concept

Known as concept art, it is nothing more than the formulation of a possible solution to a problem or need that a person has, which would be determined in the briefing. The concept is the idea through which the element is defined and contextualized in a concrete reality. The art represents this concept with an aesthetic that will be used as a reference in the production phase. Thus, good concept art is the one that provides the most accurate and precise information for the production phase.

Sketching and fitting

It showed the outline of what will be in the future, the final proposal of the project. If the client or target audience likes it, then continue with the development of the project. This is how it is understood that the sketch or sketching process is not a step where ideas go as drafts. Unlike the drafts, a sketch is the next step to take, since once the base ideas are obtained, it is necessary to start polishing details and adding information. Making clear the sketching process to better analyze the issue of features, details of the concept to be represented, and the creation of the front and side views that are essential for the realization of 3D modeling, as its main function is to guide the modeling.

Each illustration was followed by the fitting, which is the reduction to simple forms, almost always geometric, of the complex structures (Figure 2, Appendix), almost always geometric, of the complex structures that contain or structure structures that contain or structure the models we want to represent. For this purpose, a box was used to reduce the objects to basic shapes such as a cylinder, sphere or cube, or cube, which serve as a reference to better understand their structure and their proportions. For any illustration, it should be

understood that any element that appears, be it a character or an object from the object in the environment, can be simplified into geometric shapes.

2.2 Production Phase

This phase establishes the techniques and software used in the project. In this case, we will use Maya Autodesk and Adobe Substance Painter, both software with educational licenses. The phase had the following sub-phases:

Blocking

In this process, we used as a guide the front and side view of the character and went from concept art to 3D model, serving to establish the number of elements that will compose the final model, establish its proportions, and silhouette. The idea was to create a model using the basic polygons so that it could be easily modified in later phases of the process.

Box Modeling

It is a process in which the distribution of the mesh and the correct topology is controlled, which refers to the number of faces that make up the polygons of the modeling, and for this work, the topology of quads (square) was used. The objective of this modeling is to obtain three-dimensional shapes with the least amount of mesh to preserve the geometric shapes that are the basis for the creation of the characters.

UV's

By means of UV mapping, the 3D figures were disassembled in a two-dimensional plane to reach the texturing stage. In the present project, a much lower polygonal mesh was achieved, and not with so much detail. Each texture was confirmed by a sector or map, square, so it extends the polygonal mesh to adapt to this sector, and that texture is coupled to the shape of each part of the modeling created.

Lighting

We used lighting that simulates an interior light with the area lights ideal to represent realistic lights, which can be used more than one and simulate a photographic studio lighting.

Bake

The different maps that are projected on the low-poly models were created. In this way, the Normal, Curvature Map, Ambient Occlusion, Position and Thickness Map have been generated using Adobe Substance Painter software for this project, and the ones used are the following:

Diffuse: Generated the true appearance of the color being given to the model.

Normal: It was based on joining and preparing the two meshes, creating a single one, so that these details can be distinguished, and that a drastic change in the fusion of the two meshes is not seen.

Roughness: It served as a base to be able to configure how rough the surface of the model needs to be defined.

Texturing

It was done using Maya Autodesk software, which allowed for the simulation of different materials (metal, wood, etc.) and gave greater detail to certain shapes. It depends, then, on the texture and the modeling mesh.

Render

To develop the modeling of the characters, we used the Maya Autodesk program, which is much lighter. Within this program, we placed the camera, lights, focus or blur, and the type of aperture of the camera diaphragm.

2.3 Post Production Phase

The last phase allowed us to establish the assembly templates for each character, which were designed in UVs in Autodesk Maya.

Template and packaging design

In this phase, the templates were designed, the sizes were adjusted, and the necessary flaps for cutting and folding were designed. The color that represents each character was also established, as well as the texture details of each garment, leaving the template ready to be printed on paper. Finally, in the Packaging, the presentation box of the character is created to protect the paper toy and, at the same time, give support to communicate who the character is and what legend it represents. The design and color of each box are according to the legend that represents each character. Once each phase of the methodology and the activities to be carried out in each one of them are defined, the methodology proposed in the character Jozep Schneidewind of the legend “The cemetery chair” is applied, where the methodological proposal shows the use of the three main phases and sub-phases that are: Pre-production: Concept art and Sketching, Production: Blocking, Box modeling, UV's, Lighting, Bake, Texturing and Rendering and Post production: Template design and packaging, Figure 3 (Appendix) shows in summary the whole process

carried out to achieve the Paper Toy of the character Jozep Schneidewind.

2.4 Evaluation of the Template

We worked with a focus group of 25 students of the Graphic Design course Packaging, for which a questionnaire was applied with 10 questions that were considered, and the average values reached in each of them represent the evaluation of the paper toy assembly process. For the analysis of the results, the arithmetic mean, or average, is a measure of central tendency used to summarize the data with a single representative value. In addition to the data obtained from the mean, the decision rule was applied, which is a criterion used to interpret the results and classify them into different levels or categories.

3 Results

To evaluate the designs of the six paper toy characters of the legends of the city of Riobamba, we worked with a focus group of 25 Graphic Design students of the Packaging course. The participants filled out a questionnaire validated by experts and consisting of 10 questions, to be evaluated according to a Likert scale from 1 to 5. The questions were oriented to the evaluation of the paper toy assembly, as well as to an overall assessment of the activity in relation to various aspects. The evaluation was made according to the following categories: not at all pleasant (1); not very pleasant (2); pleasant (3), quite pleasant (4); very pleasant (5).

Table 4 (Appendix) shows the questionnaire applied with the 10 questions that were considered and the average values reached in each one of them, which represent the evaluation of the paper toy assembly process.

For the analysis of the results, the arithmetic mean, or average, is a measure of central tendency used to summarize the data with a single representative value. This value provides a general idea of what the "center" of the data is and is useful in many applications to understand patterns and make informed decisions, the results of which are presented in Table 5.

In addition to the data obtained from the mean, the decision rule was applied, which is a criterion used to interpret the results and classify them into different levels or categories. In the context of the document analysis, the decision rule whose values are shown in Table 5 helps to determine whether the results of the questions are considered low, medium, or high according to their average score.

Table 5. Results oriented to the evaluation of the paper toy assembly

1	2	3	4	5	Average	Scale
0	0	0	3	22	3.72	HIGH
0	0	4	17	4	4.00	HIGH
2	3	7	8	5	3.44	HIGH
4	2	10	8	1	3.00	HALF
0	3	7	10	5	3.68	HIGH
0	0	4	12	9	4.20	HIGH
0	0	5	8	12	4.28	HIGH
0	0	2	6	17	4.60	HIGH
1	0	3	10	11	4.20	HIGH
0	0	2	10	13	4.44	HIGH

Source: created by the authors

This scale makes it possible to classify the opinion or perception of the participants in a clear and quantifiable way. If a question scores an average in the HIGH category, it is interpreted as a positive result. If it is in the MEDIUM category, it is moderate and could indicate a need for improvement. A LOW category would reflect a negative perception or an area with significant opportunities for improvement. The overall result indicates that most of the questions evaluated have an average score within the HIGH category, suggesting a positive perception of the activity analyzed. The implicit decision scale is used to rank these averages:

HIGH (3.34 - 5.00): represents 9 responses that fall into this category, reflecting a positive assessment of the evaluated aspects, such as identification of the characters, use as an educational resource, stimulation of creativity, and the relationship of 2D and 3D design concepts.

MEDIUM (1.68 - 3.33): A response related to the ease of construction of the Paper Toys falls in this category, indicating that some participants found some challenges in this area.

LOW (1.00 - 1.67): There were no responses that fell into this category, indicating that no aspect was evaluated as deficient by the participants.

The overall analysis shows a high degree of acceptance and effectiveness of the Paper Toys construction activity, highlighting both its educational value and its ability to stimulate creativity and assist in teaching design and cultural heritage concepts. Areas for improvement include ease of construction and preference for larger sizes of paper toys, as similar research has shown.

The experience of 3D printing established a physical connection between creativity and the constructed world, motivating upcoming

generations of designers to incorporate 3D printing into learning environments to transform architecture education. Additionally, the research uncovered the beneficial effect of 3D printing in enhancing teamwork and interaction among kids as they collaborated on designing and producing their models, [23].

[24] verified the utility of 3D pens as an enhancement to conventional education for studying anatomical components such as the chewing muscles. Integrating 3D pens and comparable technologies in dental training could lead to more creative and captivating instructional strategies, likely boosting student involvement and the memory of intricate

According to [25], those who claim that ata and smart technologies have considerable capacity to change early education for young children. Nevertheless, issues like security threats, obstacles to implementation, and gaps in research need to be tackled via creativity, teamwork across various fields, and strong research methods.

However, [26] propose that intelligent game-focused methods are notably successful in promoting visual and spatial growth among preschoolers. The incorporation of engaging, organized smart play in early education can greatly improve kids' mental capabilities, especially in areas like spatial reasoning and problem-solving.

4 Discussion

The results show that the combination of the proposed methodology and software tools proved to be effective for the creation of templates of 3D geometric characters, objects, and scenarios to be assembled on paper and used as didactic material. Each of the methodology phases applied together with the specialized software, such as Autodesk Maya 3D and Adobe Substance 3D Painter, both with educational licenses and vector software, allowed achieving an optimal result in the creation of paper toys, as in similar research, [27], [28].

Nine of the 10 questions obtained a rating in the HIGH category, which indicates a very positive perception of the participants about the analyzed activity, and only one question (number 4) was placed in the MEDIUM category, thus validating the paper toys elaborated and the creation methodology used, which allowed reaching satisfactory results, as has been observed in similar methodologies, [29], [30].

It is of utmost importance to start from the illustrations of the narrative cultural manifestations of Ecuador, in this specific case, from the documented legends of Riobamba, this approach has allowed connecting technology with local culture, thus enriching the creative process, which will contribute to the cultural heritage of Ecuadorian ancestral values, which can not only be applied to the field of narrative, but also to the preservation of other values such as gastronomy and local knowledge, [31], [32].

It emphasizes the significance of the briefing as an essential resource for creating design projects, as it provides a well-organized and straightforward framework. In this instance, the briefing has been vital in establishing the features and goals of the project focused on 3D modeling paper toys that represent the narrative cultural heritage of Ecuador, which serves as the primary means for safeguarding traditional knowledge, [33], [34].

This study validated an effective methodology for the creation of paper toys that represent the legends of Riobamba, and highlighting the importance of the briefing in the creative process, [35], [36], the results show that the 25 participants are satisfied with the product delivered, highlighting the educational and didactic value of the paper toys to learn about the cultural narrative manifestations of the city of Riobamba, a methodology that can be extrapolated to other Andean cultures with similar characteristics.

Developing AV models still demands substantial resources, including knowledge, time, and facilities. Conditions characterized by complexity that could benefit most from AV models are frequently rare, necessitating extended study durations and cooperation among various locations, which leads to a lack of published research. These challenges have restricted the quantity of definitive research confirming the clinical relevance and practical use of 3D AV models, [37].

For instance, 3D printing with health-related aims has revealed that the high expenses linked to acquiring cadaveric temporal bones (TBs) have prompted numerous individuals to look for less expensive options for surgical training using TBs. Various research efforts demonstrate that resin 3D-printed TBs possess face validity, serving as reliable and effective substitutes for practicing TB dissections, [38].

Nonetheless, this innovative teaching tool created through 3D printing acts as a valuable resource for practicing microvascular anastomosis in neurosurgery. It presents notable benefits, including improved training efficacy, realistic simulations, affordability, and options for personalization. These outcomes could also apply to

various other fields of education, including engineering and the natural sciences, [39].

5 Conclusions

The 3D modeling methodology for the creation of paper toys was successfully validated, which is a pedagogical tool that will provide teachers and people in general the possibility of creating templates to obtain 3D digital modeling with geometric styling, keeping the representative aesthetics of each of the characters, which in the case of its application in the context of ancestral cultures, maintains the characteristics of the historical characters with the added value that is attractive to users, which facilitates the teaching-learning process.

In this study, specialized software such as Autodesk Maya 3D educational version was used for modeling, as well as Adobe Substance 3D Painter programs to add textures in each modeling and finally Adobe Illustrator to create templates and packaging for each of the characters, which were relevant to create templates of any character and make the assembly of 3D shapes on paper, helping to accurately determine the graphic style, personality, clothing of each character.

The use of 3D paper toy modeling of Ecuador's cultural narrative manifestations, which is the main way to protect ancestral knowledge, with the additional advantage that this methodology shows a high degree of acceptance and effectiveness of the Paper Toys construction activity, highlighting both its educational value and its ability to stimulate creativity and help in the teaching of design concepts and cultural heritage. Areas for improvement include ease of construction and preference for larger sizes of paper toys.

References:

[1] Cui ., «Design and printing of proprioceptive three-dimensional architected robotic metamaterials.», *Science*, 376, 6599, pp.:1287-1293. 2022. https://doi.org/10.1126/science.abn0090.

[2] Guo., «Explicit and efficient topology optimization for three-dimensional structures considering geometrical nonlinearity.», *Advances in Engineering Software*, 173, 103238. 2022. http://dx.doi.org/10.1016/j.advengsoft.2022.103238.

[3] Fauzi., «Paper Airplane Toys: Interpreting Children's Thinking.» *Journal Iqra': Kajian Ilmu Pendidikan*, 8(1), pp. 224-242. 2023. https://doi.org/10.25217/ji.v8i1.3198.

[4] Elhage ., «Toy models of superposition.», *arXiv preprint arXiv*: 2209, 10652. 2022. http://dx.doi.org/10.48550/arXiv.2209.10652.

[5] Coates, «The Paper-Engineered Pumpkin King: Exposing the Movable Impulse of Tim Burton's The Nightmare Before Christmas», *Adaptation*, 17(3), pp. 394-413. 2024 doi:10.1093/adaptation/apad031.

[6] Bell ., «Craft imaginaries–past, present and future», *Organization theory*, 2(1), 2631787721991141. 2021. http://dx.doi.org/10.1177/2631787721991141.

[7] Rodríguez-Miranda ., «Interactive virtual representation of the disappeared convent of El Carmen (Logroño) generated from a paper craft model», *Virtual Archaeology Review*, 12(24), pp. 77-89. 2021. http://dx.doi.org/10.4995/var.2021.14038.

[8] Lehrecke ., «Tailored lace: moldless fabrication of 3D bio-composite structures through an integrative design and fabrication process», *Applied Sciences*, 11(22), 10989. 2021. https://doi.org/10.3390/app112210989.

[9] Agrain ., «Representing and Creating 3D Bobbin Lace», *Digital Presentation and Preservation of Cultural and Scientific Heritage*, 13, pp. 159-168. 2023. http://dx.doi.org/10.55630/dipp.2023.13.15.

[10] Učakar ., «3D digital preservation, presentation, and interpretation of wooden cultural heritage on the example of sculptures of the FormaViva Kostanjevica Na Krki collection», *Applied sciences*, 12(17), 8445. 2022. https://doi.org/10.3390/app12178445.

[11] Hou ., «Digitizing intangible cultural heritage embodied: State of the art. *Journal on Computing and Cultural Heritage* (JOCCH), 15(3), pp. 1-20. 2022. https://doi.org/10.1145/3494837.

[12] Munkberg ., «Extracting triangular 3d models, materials, and lighting from images», In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* (pp. 8280-8290). 2022. https://doi.org/10.1109/CVPR52688.2022.00810.

[13] Deitke ., «Objaverse: A universe of annotated 3d objects», In *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition* (pp. 13142-13153). 2023. http://dx.doi.org/10.1109/CVPR52729.2023.01263.

[14] Fu ., «Students' attitudes and competences in

modeling using 3D cartoon toy design maker», *Sustainability*, 14(4), 2176. 2022. http://dx.doi.org/10.3390/su14042176.

[15] Hassija ., «Interpreting black-box models: a review on explainable artificial intelligence», *Cognitive Computation*, 16(1), pp. 45-74. 2024. https://doi.org/10.1007/s12559-023-10179-8.

[16] Ma ., «Imagenet3d: Towards general-purpose object-level 3d understanding», *Advances in Neural Information Processing Systems*, 37, 96127-96149. 2024. http://dx.doi.org/10.48550/arXiv.2406.09613.

[17] Torres ., «Potential of 3D printing in revolutionizing solar-driven interfacial evaporation for clean water supply–A review», *Applied Materials Today*, 43, 102639. 2025. https://doi.org/10.1016/j.apmt.2025.102639.

[18] Wang ., «Innovative Designs of 3D Heat Sinks by Topology Optimization», *Journal of Mechanical Design*, 147(8). 2025. http://dx.doi.org/10.1115/1.4067870.

[19] Iftekar ., «Advancements and limitations in 3D printing materials and technologies: a critical review», *Polymers*, 15(11), 2519. 2023. https://doi.org/10.3390/polym15112519.

[20] Rouf ., «Additive manufacturing technologies: Industrial and medical applications», *Sustainable Operations and Computers*, 3, pp. 258-274. 2022. https://doi.org/10.1016/j.susoc.2022.05.001.

[21] Chlubna, T., Vlnas, M., Milet, T., & Zemčík, P. (2025). Survey of FOSS 3D/2D graphics software Blender usage in science, academia, and industry. *The Visual Computer*, *42*(1), 95. https://doi.org/10.1007/s00371-025-04281-1.

[22] Rahman and Umri, «Analysis of Inverse Kinematics Techniques for 3D Animation Human Characters Using Autodesk Maya», *SMART: Jurnal Teknologi Informasi dan Komputer*, 3(2), pp. 116-125. 2024. http://dx.doi.org/10.1109/ICORIS.2019.8874870.

[23] Qurraie, B. S., Özeren, Ö., & Na-Allah, M. S. G. (2025). Building imagination in 3D: The design by children with architecture and 3D printing. Entertainment Computing, 52, 100904. https://doi.org/10.1016/j.entcom.2024.100904.

[24] Mathew, R. S., Daniel, A. Y., & Jolly, S. (2025). Three- dimensional Pen—A New Teaching Learning Method for Teaching Masticatory Muscle Anatomy. Journal of Dental Education, e13965. https://doi.org/10.1002/jdd.13965.

[25] Liu, J., Chen, M., He, H., Liu, H., Luo, W., & Li, H. (2025). Forms and functions innovation: a scoping review of digital and intelligence technologies in early childhood education practice. AI, Brain and Child, 1(1), 1-15. https://doi.org/10.1007/s44436-025-00010-6.

[26] Nurhidayat, M., Neo, M., Azhar, H., Afif, R. T., & Aurumajeda, T. (2026). Optimization of digital minecraft games as a media for stimulating creativity and imagination. En B. Subhi Awwad (Ed.), *Intelligent Governance in the Big Data Era: Finance and Sustainability in Developing Nations* (pp. 441-450). Springer Nature Switzerland. https://doi.org/10.1007/978-3-032-14698-4_42.

[27] Wilkinson, C. M., Roughley, M., Liu, C. Y. J., Shrimpton, S., Davidson, C., & Dickinson, T. (2026). The affordances of ai-powered, deepfake, avatar creator systems in archaeological facial depiction and the related changes in the cultural heritage sector. *Applied Sciences*, *16*(2), 1023. https://doi.org/10.3390/app16021023.

[28] Lazăr and Brăileanu, «Advanced Modeling and 3D Printing Techniques for Game and CGI Characters. The Annals of "Dunarea de Jos», *University of Galati. Fascicle IX, Metallurgy and Materials Science*, 47(3), pp. 32-37. 2024. http://dx.doi.org/10.35219/mms.2024.3.06.

[29] Huang and Wang, «Effectiveness of a three-dimensional-printing curriculum: Developing and evaluating an elementary school design-oriented model course», *Computers & Education*, 187, 104553. 2022. https://doi.org/10.1016/j.compedu.2022.104553.

[30] Jovanovic ., «3D printed toys for children with disabilities–study case in Montenegro», In *International Conference "New Technologies, Development and Applications" May Cham: Springer Nature Switzerland* (pp. 276-282). 2023. http://dx.doi.org/10.1007/978-3-031-31066-9_29.

[31] Yani, M., Desyandri, D., Adrias, A., & Rahmi, U. (2026). Development of interactive teaching materials on google sites using a problem-based learning model for fifth-grade indonesian language instruction. *Journal of Educational Sciences*, *10*(1), 1750-1765.

https://doi.org/10.31258/jes.10.1.p.1750-1765.

[32] Adefila, E., Oladokun, B. D., & Adewojo, A. A. (2026). Beginning of a new era: Leveraging digital twin technology in the preservation of indigenous knowledge systems in the disruptive era. Library Hi Tech News, 43(2), 4-8. https://doi.org/10.1108/LHTN-05-2024-0088.

[33] Almeida ., «Enhancing Kichwa Language and Ancestral Identity in New Generations Through Oral», *Artificial Intelligence, Computer and Software Engineering Advances: Proceedings of the CIT 2020*, Volume 2, 1327, 374. 2021. http://dx.doi.org/10.1007/978-3-030-68083-1_28.

[34] Zhang, Y. (2026). Transcultural shōjo manga: Rethinking the Italian comic series *W.I.T.C.H* . through Heinrich Wölfflin's art-historical comparative methodology. *Journal of Graphic Novels and Comics*, 1-35. https://doi.org/10.1080/21504857.2025.2484404.

[35] Han ., «Is group work beneficial for producing creative designs in STEM design education?», *International Journal of Technology and Design Education*, pp. 1-26. 2021. https://doi.org/10.1007/s10798-021-09709-y.

[36] Vahabi ., «Impact of project briefing clarity on construction project performance», *International Journal of Construction Management*, 22(13), pp. 2504-2516. 2022. http://dx.doi.org/10.1080/15623599.2020.1802681.

[37] Sarkar, K., Bhimarasetty, V., Rahim, A., Curtis, C., & Hughes, K. (2025). Assessing the feasibility and utility of patient-specific 3D advanced visualization modeling in cerebrovascular disease: retrospective analysis and prospective survey pilot study. JMIR Formative Research, 9, e51939. https://doi.org/10.2196/51939.

[38] Nwosu, O. I., Quesnel, A. M., Crowson, M. G., & Gray, S. T. (2025). Considering the Costs: Resin 3D Printing for a Temporal Bone Dissection Course. Otolaryngology–Head and Neck Surgery, 172(3), 1069-1071. https://doi.org/10.1002/ohn.1042.

[39] Shi, G., Ren, H., Zhao, D., Cui, Y., Su, X., Yan, S., & Bu, W. (2025). Feasibility and practicality of a novel teaching aid for microvascular anastomosis simulation training in neurosurgery generated by 3D printing. Frontiers in Surgery, 12, 1546573. https://doi.org/10.3389/fsurg.2025.1546573.

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APPENDIX

Table 3. Description of the personage Schneidewind Jozep

DESCRIPTION OF THE PERSONAGE	
Legend:	*The cemetery chair*
Name of personage:	*Schneidewind Jozep*
Legend development period.	*modern*
Age of the character:	*25 years*
Description: He was a handsome young man who always dressed elegantly and impeccably, and was also a caring and altruistic human being.	
Attire: Formal suit, brown leather shoes, white shirt, and black tie.	**Personality:** tender, cultured
ILLUSTRATIONS 	

Source: created by the authors

Table 4. Questions formulated for the evaluation of the paper toy assembly

N	Question Statement
1	Were you able to clearly identify the character you were assigned to create and relate it to the legend it represents?
2	Are the colors and textures used in the design of each character consistent and contribute to its recognition?
3	Do the volumes used allow us to properly identify which character the Paper Toy represents?
4	Was the Paper Toy easy to build?
5	Does building paper toys improve your spatial vision?
6	Is the construction of paper toys a good educational resource?
7	Does building paper toys stimulate your creativity?
8	Would it be easier to cut and build the paper toy if it were bigger?
9	Is building paper toys an interesting activity to relate 2D and 3D design concepts?
10	Is building paper toy sculptures an interesting way to learn about cultural heritage?

Source: created by the authors

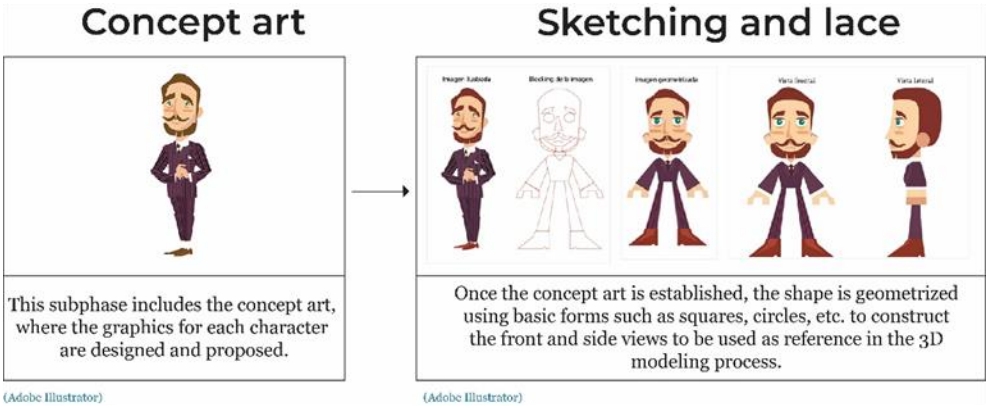

Fig. 2: Workflow of the pre-production stage
Source: created by the authors

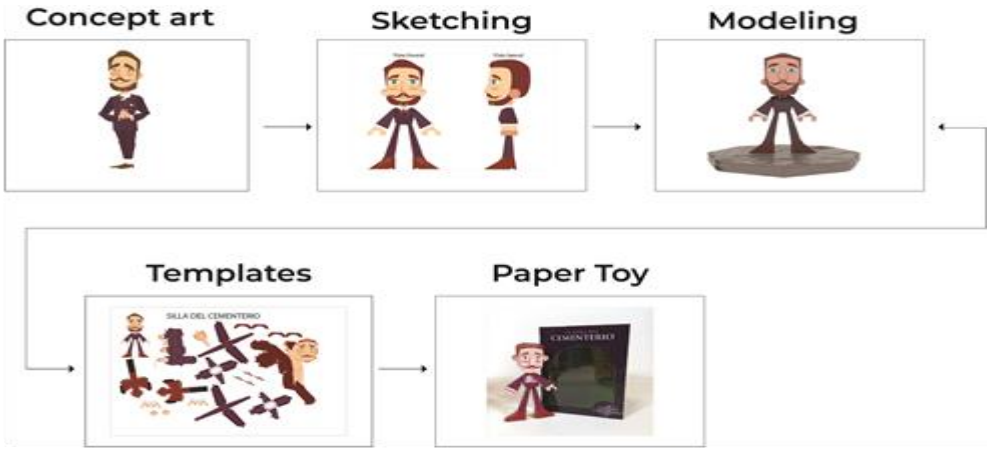

Fig. 3: Final result of "The Cemetery Chair" following the proposed methodology
Source: created by the authors