

Light and Geometry: An Artistic-Mathematical Experience in Primary School

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Abstract

In this paper, we present an educational project for Primary School based on the lightpainting technique. School children aged 10–11 were introduced to this technique and recorded in photographs the motions and geometric shapes made with the multi-colored luminous objects. Through this medium, we allowed students to experience and play with simple geometric ideas through bodily motion and photography, while addressing Spanish curriculum requirements (Art and Mathematic sections).

Introduction

In this work we present a didactic experience in which geometry is worked through the lightpainting technique. This project was carried out in a fifth-grade classroom of Primary Education (10–11 years, in Spain).

Light painting is defined as a photographic technique that consists of photographing the shape and movement of different types of light [2]. The technique dates back to the year 1889, when George Demeny placed incandescent bulbs at the joints of a person and created what is considered the first lightpainting photograph called "Pathological walk from the front". Years later, specifically in 1935, the technique evolved in the hands of the well-known, Vanguardia era photographer Man Ray, who produced the series 'the writing space' in which we can find numerous photographs taken with lights. To realize them, Ray darkened his study and experimented with different types of lines and swirls of light using light bulbs and flashlights in order to capture them with his camera [3].

Subsequently, Gjon Mili began using strobe lights and electronic flash to photograph the movement associated with different artistic disciplines such as dance or music [6]. Mili put lights on the boots of ice skaters to record the movement of each of them with his camera, which was a great source of inspiration for other photographers who practice this technique of lightpainting. He also took a series of photographs of Picasso making a great variety of drawings with lights among which were classic figures by this painter, such as bulls or centaurs [5].

Description of the Project: Aims and Contents

One of the main objectives of this work is to consider luminous objects as an artistic resource using the lightpainting technique as inspiration. For this, we designed a project for students in fifth grade (10–11 years) which consisted of performing an artistic activity of experimentation, realization and subsequent exposure of photographs of geometric inspiration using this technique of light painting. Specifically, it aims to achieve four objectives: (1) to work visualization, layout and spatial memory; (2) to recognize the different types of lines, the mathematical relationships established between them and the geometric plane and 3D forms; (3) to

encourage collaborative work; and (4) to make a collective artistic creation by using different lights and colors.

Considering the Spanish government decree 105/2014 through which the curriculum of Primary Education is established, the contents covered in the project are those belonging to block 4 of the area of Mathematics associated with Geometry, as detailed below:

- B4.1. Relative positions of lines and circles.
- B4.5. Flat and spatial forms: flat figures: elements, relationship and classification.
- B4.9. The circumference and the circle. Basic elements: center, ray, diameter, rope, arc, tangent and circular sector.
- B4.10. Resolution of geometry problems related to everyday life.

Regarding Visual Arts Education, we selected contents of blocks 1, 2 and 3 (Audiovisual education, artistic expression and geometric drawing, respectively):

- B1.5. Exploration of the expressive possibilities of the line according to the form, the direction, the spatial situation and the sensation of movement and rest.
- B1.7. Making photographs to collect activities of the center.
- B2.3. Spontaneously when it comes to expressing ideas.
- B2.5. Construction of structures and transformation of spaces using metric and perspective notions.
- B2.7. Analysis of the forms of representation of volumes at the plane according to the point of view or the situation in space
- B2.8. Representation with different intentions of open and closed forms, and of the limits, contours and surfaces.
- B2.16. Establishment of protocols for organization, order, cleaning and presentation.
- B3.1. Exploration of the possibilities of the straight line to start the geometry works.

Methodology: Session Development

The didactical methodology we carried out based on collaborative learning [7] thus promoting cooperation and the joint construction of the verbal and procedural knowledge of Visual Arts Education and Mathematics. The project is developed in six sessions of forty-five minutes that are described below.

Session 1: We create the dark zone

In the first session we explained to the students where the idea of lightpainting came from, showing them different images of works and artists who worked with this technique, and a video that explains it [4]. Next, the students (25) were divided in groups of five each and we presented the project. We asked each group to draw lines and geometric shapes in the air using colored lights and taking pictures of those compositions. To obtain different types of shapes and lines students could use their own arms and hands, tubes, rectangular boxes and geometric figures of cardboard and wooden slats with lanterns at their ends or on one of their sides. To vary the color of the lanterns, cellophane paper of different colors was placed on top of each one of them. With this they tried to create an artistic composition of varied colors and combine them; for example, if they draw a line of yellow light and another of blue light superposed on it, the result we get is a green line.

In this session the whole class group created the dark stage, necessary to put the project into practice, walling the corridor windows with cardboard. We explained the operation of the cameras to the first of the groups that went out to the hall to take the photos. In this way, they could take the photos and create the shapes that they wanted in the time that was given to each of the groups (15 minutes approximately). While the group was in the hall making the photos, the rest of the students, distributed in the different groups, was in the classroom making sketches

with the ideas, tracings and geometric figures that later will have been reflected in the photos. In addition, to review the drawing of bodies and geometric figures, we encouraged them to draw three-dimensional geometric bodies to dark them with different shades of white, gray and black in their sketchpad. When the change of group was made, one of the members of the previous group explained to the following how the cameras work to take the photographs correctly. In this way, the entire class group was working on the relationship that was established between light and geometry.

Sessions 2 and 3: We continue with light painting

In these two sessions we continued with the same work routine until all the groups had passed at least once to the dark zone. In the figure 1,2 ,3 and 4 we can see some examples made in the classroom.



Figure 1: *Vertical spiral*



Figure 2: *Symmetric shapes*



Figure 3: *Horizontal spiral*



Figure 4: *Parallel lines*

Session 4: Joint vision of photographs and brainstorming

When all the groups took some photographs, we envisioned them together and commented on the results. Each one of the them explained the techniques or drawings they made and how they achieved the results. Jointly, we decided what we wanted to do with them, that is, if we grouped them together and formed a collage, grouped them by shapes or colors to print them and make an exhibition, publish them on the school website, etc. After this (again in groups), they decided on the type of figures they wanted to draw in the photos (flat or three-dimensional) and how they wanted to represent them in order to organize and bring the necessary materials from home.

Sessions 5 and 6: Light painting and photography

Each of the groups brought to the classroom the objects or mechanisms that they believed could help in the realization of their project. The same work routine was followed as in sessions 2 and 3.

Evaluation

The evaluation was made by selecting the evaluation standards that best fit our project, following Decree 105/2014 [1]:

- B2. 2.3. Participates in the proposed activities and shows interest in them, collaborating whenever it is a group work.
- B2. 3.1. It represents with chiaroscuro the spatial sensation of volumetric compositions.
- B2. 3.2. Experiment with the superposition of planes to create volume.

- B2. 3.3. Use the horizontal line as an expressive element to provide a sense of depth.
- B2. 3.4. Combine and analyze the colors to use them correctly in the composition.
- B2. 5.3. Participates and shows interest in the activities, collaborating in the collection and organization of material.
- B3 1.5. Represent and properly apply the axis of symmetry.

Summary and Conclusions

This project allowed students to experience drawing through bodily motion and to develop skills that are significant from different points of view. The concrete result was an original artistic work created by the whole class group in which different techniques were combined and put into practice in a creative way by the students. While realizing the work, they developed their artistic and mathematical competences

First of all, in order to register the shapes created by movement, they put into practice lightpainting technique. The learning of this technique and its history (including the artists who put it into practice) contributed to improve the students their artistic and cultural competence.

Considering the goals related to math education, the students had to discuss about the luminous and geometrical objects that lead them to improve their mathematical knowledge. Spatial memory and basic geometric concepts (such as types of flat figures, three-dimensional bodies or types of lines) were worked on artistically through lighpainting. With the use of cameras, they improved their digital competence and sense of initiative, working with materials that are not normally used in the classroom. Students experimented creating their own resources and materials to obtain the desired results (competence to learn how to learn). In addition, they did collaborative work (social and civic competence), since they divided themselves into small work teams and established the rhythm of the session. In the oral presentation of the results that the groups obtained from this experience, the students put communicative competence into practice too.

This activity stands out for having a free character. They decided what forms they would draw in the dark space and what they would do after them being recorded in photographs. Therefore, they were able to work by themselves and with the rest of their classmates.

Finally, it should be noted that following the evaluation standards mentioned above, we took notes about the progress of each student in terms of mathematical and artistic skills. In this way, we were able to see that the students showed a positive attitude towards the activity.

Acknowledgments

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