Proc. of the Communicating Astronomy with the Public
March 2018 in Fukuoka, Japan

Representing the Universe: a hands on challenge

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Abstract. Astronomical images are representations of reality mediated by observations, meaning an instrument with its characterization (resolution, sensitivity, etc.). We propose a hands-on approach that takes advantage of the fact that many children's toys use image sampling as a gaming tool, in order to reproduce images at different resolutions. The most innovative concept of this laboratory is the introduction of hard science subjects through a playful approach, and the use of toys as research instruments. This play-based learning activity takes place in a highly inclusive and participative environment, leaving much space to personal intuition and autonomous discovery. The use of familiar objects and ludic equipment, low tech, prevents literacy barriers and gender issues and encourages immediate commitment and engagement.

1. Introduction

"Learning through play" describes a pedagogical and psychological approach according to which children make sense of the world though play. The concept is mainly based upon John Dewey's contribution [1] to the theory of constructivism [2] and Seymour Papert's theory of constructionism [3]. They basically suggest that "*education is not an affair of 'telling' and being told, but an active and constructive process*" ([2] Dewey, p.85) and that "*the best learning takes placed when the learner takes charge*" ([3] Papert, p.25). Play-based learning programs (such as the Montessori Method [4] and the Reggio Emilio Approach [5]) are student-centered learning approaches, focused on the fully autonomous development of children's cognitive, social, experiential and creative potential through play. Play-based learning should be as unstructured, creative and not content-guided as possible. "*Practitioners can and should plan for children's play, however, by creating high quality learning environments*" ([6] Moyles, p.4); they can orchestrate an environment by deciding what toys, materials, and equipment to be included in that environment.

Play-based approaches not necessarily employ toys as work equipment. In this activity we take advantage of the fact that many children's toys use image sampling as a gaming tool and make use of simple, very little structured playful stuff for reproducing images at different resolutions.

The main aims of this activity are:

- to introduce basic concepts of astrophysical imaging, such as spatial and chromatic resolution and sampling through toys and playing;
- to create an inclusive and participative environment, leaving much space to personal intuition and autonomous discovery;
- to prevent literacy barriers and encourage all children's commitment thanks to familiar objects and ludic, low tech equipment.

2. Description of the activity

The activity addresses 9-10 year-old students and includes two sessions of two hours. It is addressed to a class working in teams of 5-6 students.

2.1. First part: the pegs

In each group, 2 of the students (the "operators") are given a peg board with a colour image under it: they have to use the board as a colour sampler, inserting pegs of corresponding colours in the holes, in order to make the image recognizable to their friends (Fig.1).

Fig. 1 "Operators" at work, sampling the image through the holes of the peg

The *operators* start reproducing the image with a

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limited number of the biggest available pegs. The other group members will try and guess the subject being reproduced; meanwhile they also try and help the operators by winning more pegs for the representation. The additional pegs are obtained by drawing and guessing astronomical.

During this phase, facilitators provide the additional pegs and the paper sheets indicating what subject to draw, but also provide the language necessary to help children articulate what they see happening and perhaps ask questions, in order to expand and enhance play.

2.1. Second part: pixelization

In the second part of the activity, each group is given a color image and several sheets with grids of different sizes (Fig. 2).

Each student, or groups of 2, works on a grid, coloring each cell with a single color, chosen in order to be the most representative of the "overall" color of the box. The range of possible colors is limited to max 24 different ones, i.e. the ones already owned by the students.

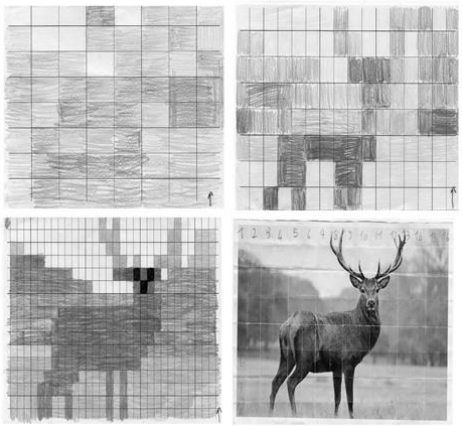

Fig. 2 The image of a deer pixelized in 64 up to 512 pixels and compared to the original one.

3. Results

The main results of the activity are as follows:

- the simplicity of the used materials, together with their friendly and daily life nature, favored an extremely positive attitude of the students;
- scientific concepts seemed to be very efficiently delivered (the "eureka moment" really occurred);
- the lab encouraged a deep personal involvement and a proficient team work.

With regards to the pegs, the "brand-issue" has been taken in to account: future developments of the lab can also include the preparation of self-made pegs-like material for the representation of images at different resolutions.

4. Conclusions

This lab clearly proved as "*the true value of play is not that it can teach children facts, but that it can help them acquire important procedural knowledge, which is beneficial in acquiring declarative knowledge*" ([7] Pinkam, p.31) We have literally seen the idea of images as data carriers rising in these children's minds, while they experimented the limits of the medium and tried to overtake them.

Next step will be to create a consistent, repeatable activity, with standard equipment, such as arranged kit or a list of material.

We have also discussed a possible third phase, which could include the digital elaboration of the images, with dedicated graphic software or educational software such scratch [8], to dig dip on the concept of quantity of information in an image. We could also turn this lab multidisciplinary creating an art gallery of deconstructed images with less and less information and relate with the work of Piet Mondrian.

We would like to thank the kids (5°C Scuola Primaria Marella IC12 Bologna) and their teacher Stefano Rini that kindly hosted our first attempt of this activity.

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