393 Codina SEEING AND DOING MATH WITH PHOTOGRAPHS

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Our presentation is about the use of photography as a resource for learning math. Photography is technically and financially accessible to most people. It is important to recognize math in real life and photography allows us to do so. This makes it easy for future teachers to capture contexts in which to see and apply mathematics. So we don't use any program to modify the images. In addition to using images as a resource, we have been doing research since 2006 into what can be learned regarding the use of photography and we have also been learning how to design activities based on it.

We began by doing activities similar to those in the Mathematical Lens section of the journal Mathematics Teacher because this type of work and its connection with reality seemed very interesting to us. An image that we used several times is the following one. We have chosen it to help address issues of numbers and geometry at the same time.

This was the proposal:
Which mathematical ideas do you see explicitly in the image?
Suggest some questions related to them.
We have done other guided activities to further explore the mathematical content of the image: Triangular numbers and packaging.

Encouraged by the wealth and possibilities of these activities and observing the positive reaction of our students we decided to go further. In the last few years, we have incorporated different types of activities with different goals and levels of difficulty.

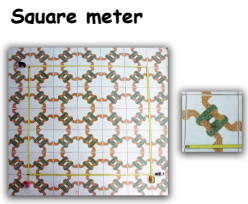
Posing and solving problems

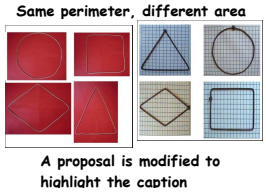
We asked them to ask questions and propose problems based on the image. The task was **to choose or take a photo and propose and solve a problem related to it**. Our aims were: a) To know how to choose images that provoke good mathematical questions; b) To relate math to reality. An example was:

"This Christmas, at the hotel where I work, they've brought sweets to give to the guests. The box measured 47.5 x 35.5 x 30 cm. Inside, there were two types of cube-shaped boxes. You can see the boxes left over in the photo. When they arrived, the cardboard box contained 12 of the big cubes. How many little boxes could there have been, at most, to fill the whole box?"

Concepts:

1. **Math captions – pictures.** We ask trainees **to interpret a short phrase or a word referring to a mathematical concept or relationship by using a photo.** You can take or find an appropriate picture. It is important to justify the relationship between the image and the phrase. Here are some examples based on our proposal for math captions.

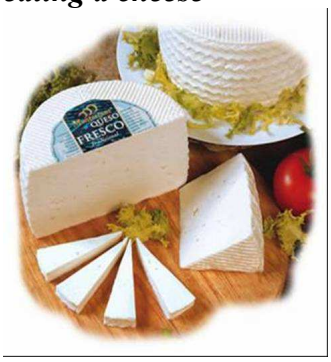




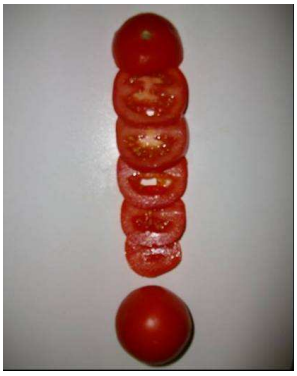
2. **Solids of revolution.** The activity is based on a talk on rounded figures. You need **to take a photo of real items where you can see some property or characteristic of a solid of revolution.**

You have to add a mathematical caption. The aims are: a) To express a property relative to a solid of revolution via a picture; b) to state a caption which gives a mathematical interpretation of the image; c) to work in groups to foster discussion and conceptual learning. These are some examples:

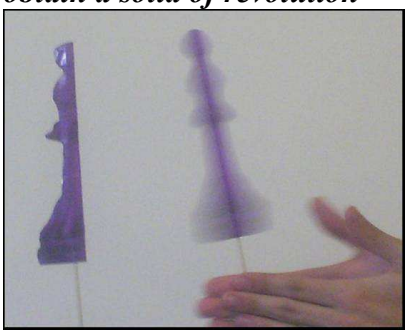
"There are many ways of eating a cheese"



"One sphere ... Infinite circles"



"With a flat figure and a rotation around a line we obtain a solid of revolution"



Common properties

We want to clarify relations in the plane and in space. We ask: **Find or take two photos that represent the same property. In one, you should be able to see the property flat, and in the other, using three-dimensional figures.** You should add the mathematical justification of the property chosen. Our aims: a) to foster the connection between flat and three-dimensional geometry, b) to face a complex task: choose the property, take or find the pictures and justify the relationship.

"Shapes and concentric bodies

In the two cases, the figures are similar. There is a proportional relationship between their measurements, and also between their perimeters, areas and volumes. The relationship between the heights of the Russian dolls in the photo is the same as that of the radii of their bases, and is approximately 1.5."

Classifications

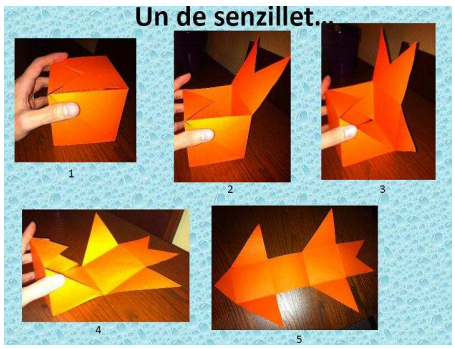
The task**: Classify the figures using various criteria. The criteria have to be geometric and clearly expressed. State in each category the property that the items share.** Suggest different classifications. The aims: a) To interpret 3D shapes from images of them; b) to classify real shapes different from school models; c) to formulate classification criteria correctly.

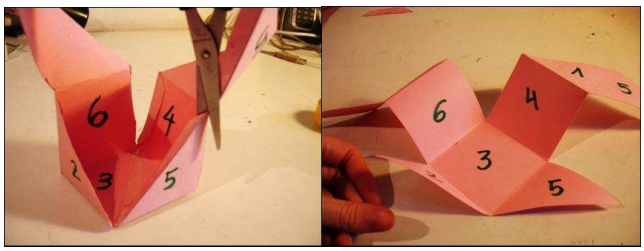
Difficulties in solving: State the classification criteria. Comprehension of the classification concept (disjoint classes). Incorrect allocation of geometric terms (bases, confusion between plane and space).
To make trainees think about what working with a photo involves compared to working with real models, we raised the question:
"Look for geometric criteria that can serve for all the bodies in the photo. There's a third dimension that we can't see and have to imagine. There's only one point of view or perspective for all the shapes. We have to reconstruct the figure from the image and from our previous knowledge".

Processes:

1. Transformation. Explain with images the process by which we obtain a net of cube which is not made up exclusively of squares. Photograph the cube, the action of cutting the faces, edges or other elements of this solid, one or more times, and finally, show its net. **The pictures should allow us to visualize the relevant moments so that they can be replicated and understood.**

Our aims: a) to broaden the concept of unfolding a cube; b) to identify the relevant moments of a transformation process; c) to work on mathematical communication in the description of a process by using appropriate vocabulary and other resources. Examples:

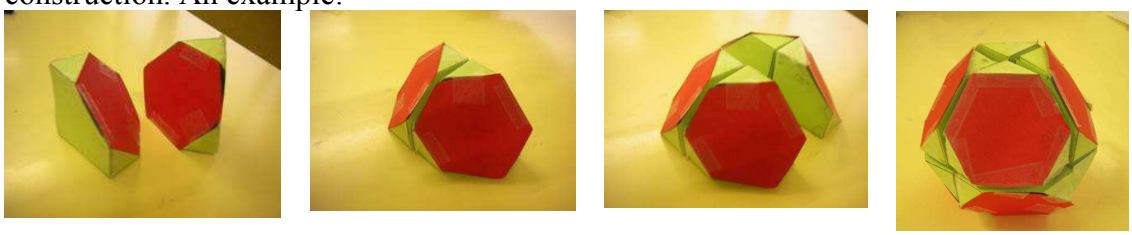




2. Construction.

Here we have the process of making a shape by using modules obtained by cutting a cube in half. **Design a sequence of 5 to 7 photos that shows the process to obtain the shape made up of 8 modules like one of the following. The images should show the relevant moments so that they can be replicated and understood.**

The aims: a) To generate and study convex polyhedron from modular dissections of a cube; b) to obtain new solids from joining repeated modules; c) to represent a process of construction. An example:



What we've learnt from this experience:

They tend to take photos themselves rather than look for them on the Internet. This is really interesting because we believe it requires greater reflection on the concept. They have to choose and discuss alternatives, and also consider how they want to use the photo and who the task is aimed at. It has been very positive in terms of motivation. Students recognize that taking photos makes them look at reality from a mathematical point of view. Many take notes with their cameras! However, we have also had problems with teacher trainees' low level of understanding of geometry.