



Project number: 2018-1-IT02-KA201-048274

Intervention Tool

3D Cartesian coordinate systems

1. Introduction

This intervention tool aims to make the students familiar with 3D coordinate systems and with the identification of coordinates and points.

2. Theoretical framework of reference

Karagiannakis's and colleagues (2016), propose a model classifying the skills involved in learning mathematics into four domains: core number, memory, reasoning, and visual-spatial. The results of their research support the hypothesis that difficulties in learning mathematics can have multiple origins and they provide a means for sketching students' mathematical learning profiles.

The herein described intervention tool is related to the Visual-spatial domain as well as with the mathematical domain Geometry since the students are asked to observe and locate points in the 3D cube.

1) From another point of view, the **Center for Applied Special Technology (CAST)** has developed a comprehensive framework around the concept of Universal Design for Learning (UDL) (<http://www.udlcenter.org>) with the aim of focusing research, development, and educational practice on understanding diversity and facilitating learning; UDL includes a set of Principles that focus on individual differences as an important element to understand and design effective instruction for learning. To this aim, UDL advances three foundational principles:

- 1) Provide multiple means of representation;
- 2) Provide multiple means of action and expression;
- 3) Provide multiple means of engagement.

2) Another theoretical reference comes from the **European Project FasMed**, focused on formative assessment in mathematics and science, (<https://research.ncl.ac.uk/fasmed/>), conceived as a method of teaching where information around the student's accomplishments is interpreted and used by instructors, learners, or their peers, to make choices about the following steps.

3. Design

In the subsections, the activities of the intervention tool are presented in detail:

3.1. Difficulties identified through the B2 questionnaire

The intervention tool is presented in reference to the difficulties shown by the students in understanding coordinate Cartesian systems as in exercises 27 and 28 in questionnaire B2.

3.2. Cognitive area and math domain of interest

Visual-spatial/Geometry

3.3. Educational Aims

Identification of coordinates in the 3D space.



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3.4. Addressing to Student /class

The intervention tool may be addressed to all the class.

3.5. Educational activities: the Intervention Tool

It is expected that this activity provides an opportunity to work the student's persistence (UDL principle *Engagement*), improve the ability to set goals and strategies to achieve them (UDL principle *Action and Expression*) as well as the skill of analysing visual information and learning through different support media (UDL principle *Representation*).

The discussion that will arise throughout the experience will allow the teacher to informally evaluate the students' comprehension and progress and identify concepts that students are still struggling to understand so that adjustments can be made to future lessons, therefore allowing formative assessment.

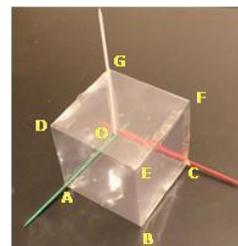
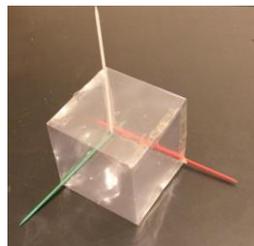
Required material:

- 10 cm edge cube built with thick transparent plastic.
- Plastic rods from the "Mikado" (= Pick Up Sticks) game.

The activity is planned to last 45 minutes and will be developed in two stages: in the first, points whose coordinates are positive or null will be identified; in the second stage, changing the Cartesian referential, the points will have coordinates that are positive, negative and / or null.

1. Identify each edge of the cube with a letter and place plastic sticks from the game "Mikado" (= Pick Up Sticks) with different colors on three competing edges, as shown in the first figure below, so that:

- The green plastic rod represents the OX axis.
- The red plastic rod represents the OY axis.
- The white plastic rod represents the OZ axis.



Since the cube has a 10 cm edge, the coordinates of the marked points are:

O (0, 0, 0), A (10, 0, 0), B (10, 10, 0), C (0, 10, 0), D (10, 0, 10), E (10, 10, 10), F (0, 10, 10), G (0, 0, 10).

2. Place three plastic rods from the "Mikado" of different colors intersecting in the center of two parallel faces as shown in the figures below, so that:

- The red rod represents the OX axis.
- The green rod represents the OY axis.
- The yellow rod represents the OZ axis.

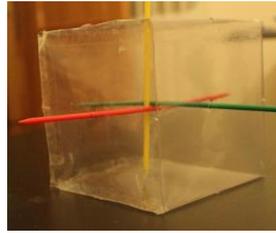
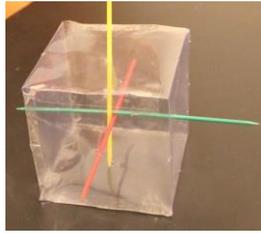


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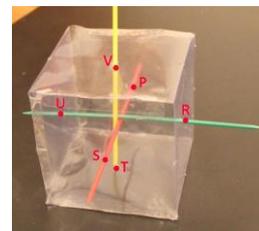
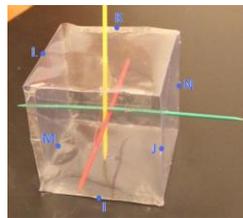
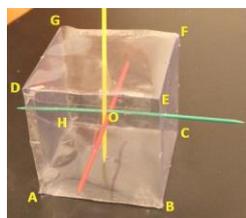
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Then, and taking into account that the edge of the cube measures 10 cm, letters will identify the vertices, the centers of the faces and some midpoints of the edges of the cube:



- Identify the vertices of the cube with a letter and indicate its coordinates: O (0, 0, 0), A (5, -5, -5), B (5, 5, -5), C (-5, 5, -5), D (5, -5, 5), E (5, 5, 5), F (-5, 5, 5), G (-5, -5, 5), H (-5, -5, -5).
- Identify some midpoints of the edges and indicate the coordinates: I (5, 0, -5), J (5, 5, 0), K (-5, 0, 5), L (0, -5, 5), M (0, -5, -5), N (-5, 5, 0).
- Identify the midpoints of the faces and indicate the coordinates: P (-5, 0, 0), R (0, 5, 0), S (5, 0, 0), T (0, 0, -5), U (0, -5, 0), V (0, 0, 5).

4. References

- [1] Karagiannakis, G. N., Baccaglioni-Frank, A. E., & Roussos, P. (2016). Detecting strengths and weaknesses in learning mathematics through a model classifying mathematical skills. *Australian J. of Learning Difficulties*, 21(2), 115–141.
- [2] www.dge.mec.pt (Programa e Metas Curriculares de Matemática do Ensino Básico)
- [3] www.projectmaths.ie (Coordinate Geometry - Project Maths)



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