Intervention Tool

Powers and balls

1. Introduction
This intervention tool aims to help students who struggle to distinguish the basis from the exponent of a power as well as to practice calculations with powers.

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 Arithmetic, since the student is asked to relate the numbers in the balls to the result of the performed calculations.

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
This activity is directed to difficulties in distinguishing the basis of a power from its exponent as is the case of exercices 5, 34, 35 and 36 of questionnaire B2.

3.2. Cognitive area and math domain of interest
Visual-spatial/Arithmetic

3.3. Educational Aims
The purpose of this tool is to help students overcome difficulties with the manipulation of powers and distinguishing basis from exponents.

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 self-regulation and 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 identifying patterns and relationships, analysing visual information and relying on alternative tools to process information (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.

This activity is planned to last 45 minutes and requires an opaque bag, 15 ping pong balls, a black marker, pencil and paper.

The activity starts after a power is written in each ball. Each of the students will then take a ball from the bag and write down the value of the basis and exponent of the power in the ball. After that, without performing the corresponding calculation, he/she will say if the number in the obtained ball is positive, negative, 1 or 0.

More abstract and challenging questions can be asked, depending on the response of the group (what will happen if you change the exponent of power with basis 1? If the exponent of a power is 1, what is the value of the power?).

4. References

[1] Costa, B., Rodrigues, E., Novo Espaço - Matemática - 7.º Ano, Porto Editora, (2019).

[2] Karagiannakis, G. N., Baccaglini-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.