

# MODELLING OF ELEMENTARY MATHEMATICAL CONCEPTS USING AUGMENTED REALITY TECHNOLOGY IN PRIMARY EDUCATION



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Augmented reality technology in the professional mathematical training of prospective teachers of elementary stages

The project objective: to implement Augmented Reality (AR) technology in the specific areas of mathematical and methodological training of primary education prospective teachers.

## AR TECHNOLOGY IN MATH EDUCATION

- creating models of mathematical concepts at different levels of abstraction.
- working with models of mathematical concepts from various thematic areas of mathematical education (arithmetic, geometry, and application tasks).
- transforming the 2D model of an object (e. g. geometry shape) into a 3D model; research the model from different points of view and present the process of creating an image of the object (shape) in geometry mapping (e.g., axial symmetry).
- creating sets of tasks with a graduated level of difficulty (changing and modifying the input parameters of the model or task).
- increasing students' motivation to learn mathematics and encouraging constructivism in teaching mathematics

## METHODOLOGY

Analysis of the content of mathematical education at different levels of the educational system is a platform for creating tools for modelling mathematical concepts. In the context of Bruner's theory, it is important in mathematics education to use models of concepts at different levels of abstraction: from manipulative (enactive), through iconic to symbolic.

The aims of the presented research are:

- to identify thematic areas of mathematics to create and use models with the incorporation of AR technology,
- to create drafts of models of selected concepts in different modes of representation.

Methods:

(1) Content analysis of the mathematics curriculum at the primary level of education. The analysis was carried out with the aim of identifying specific areas of mathematics where it would be possible to apply work with tools using AR technology.

(2) Cognitive analysis of selected mathematical tasks - as a base for creating tasks of graduated difficulty.

Tools using AR technology can be applied in the context of mathematical tasks in three stages of the task-solving process:

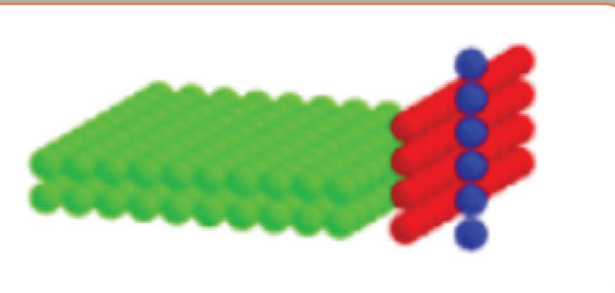
- input – creation of tasks of varying difficulty depending on a specific gradation criterion,
- process – procedure for representing the solution, creation of a model of the given concept,
- output – checking and verifying the correctness of the solution.

## DATABASE OF APPLETS – PROJECT OUTPUT

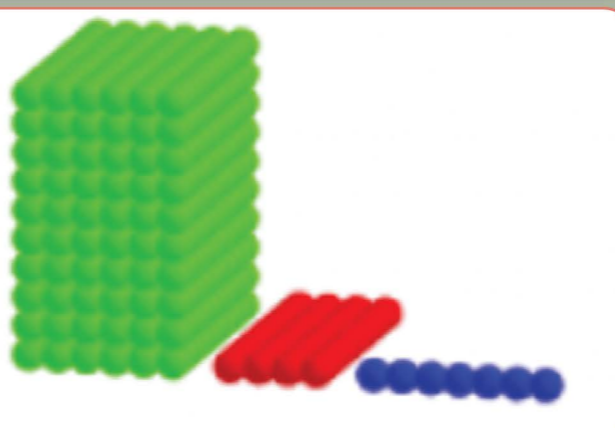
### Arithmetic

Expanded and basic forms of natural numbers  
Vertical orientation

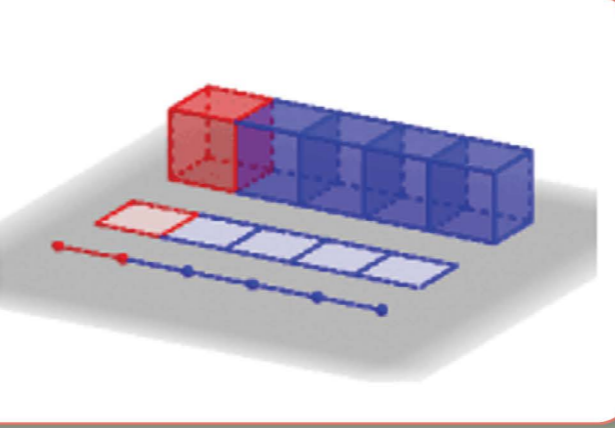
### Illustration



Expanded and basic forms of natural numbers  
Horizontal orientation



Models of fraction



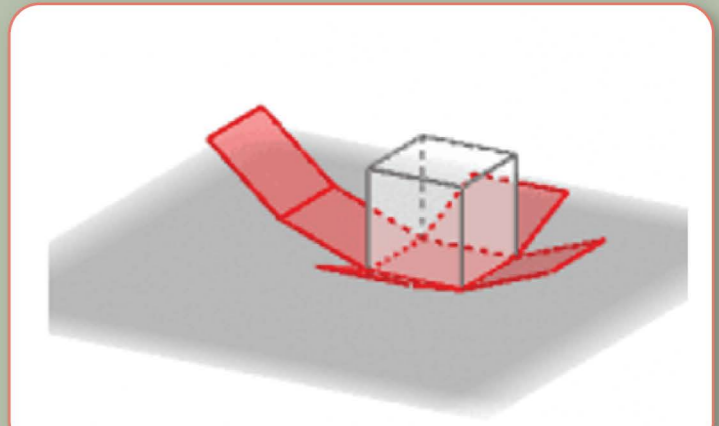
Commutative law of addition



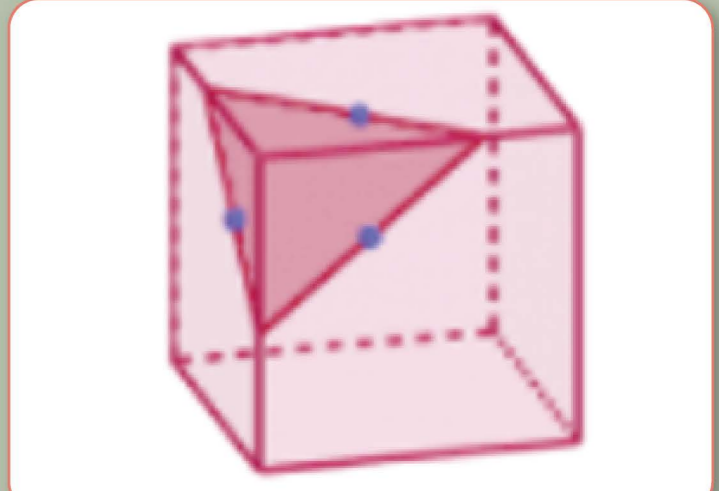
## DATABASE OF APPLETS – PROJECT OUTPUT

### Geometry

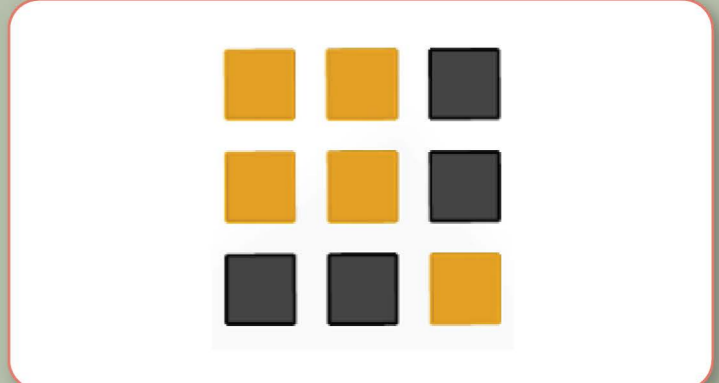
Geometry and measurement  
Stereometry – cube net



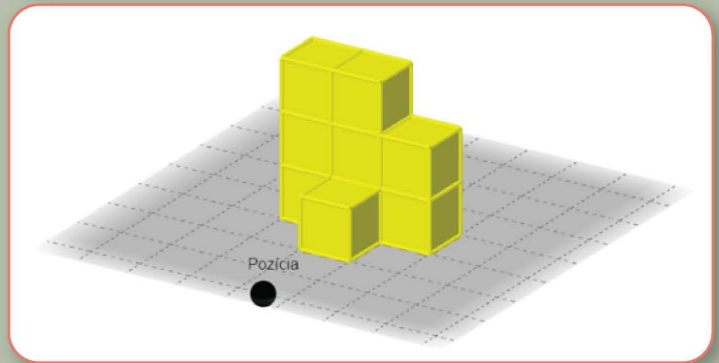
Geometry and measurement  
Shapes (2D, 3D) – cutting a cube



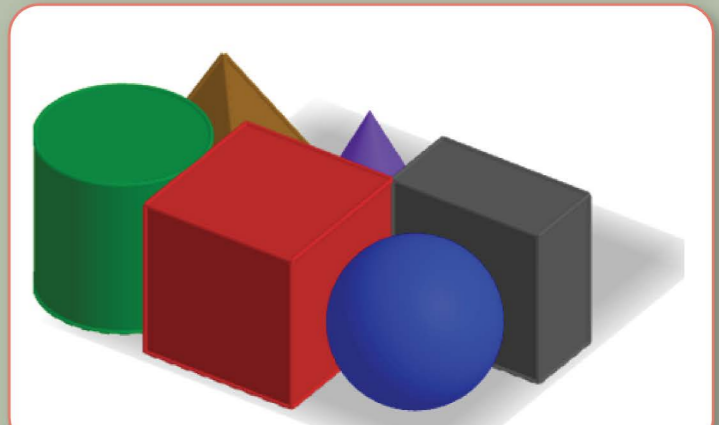
Geometry and measurement  
Axial symmetry



Geometry and measurement  
Cube building



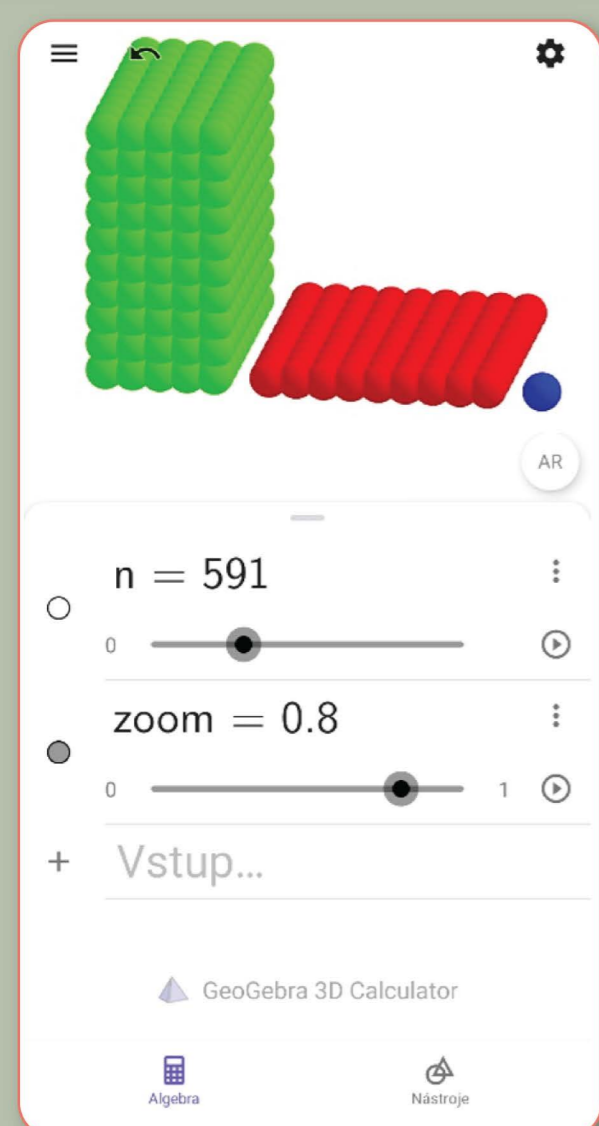
Geometry and measurement  
Solid building



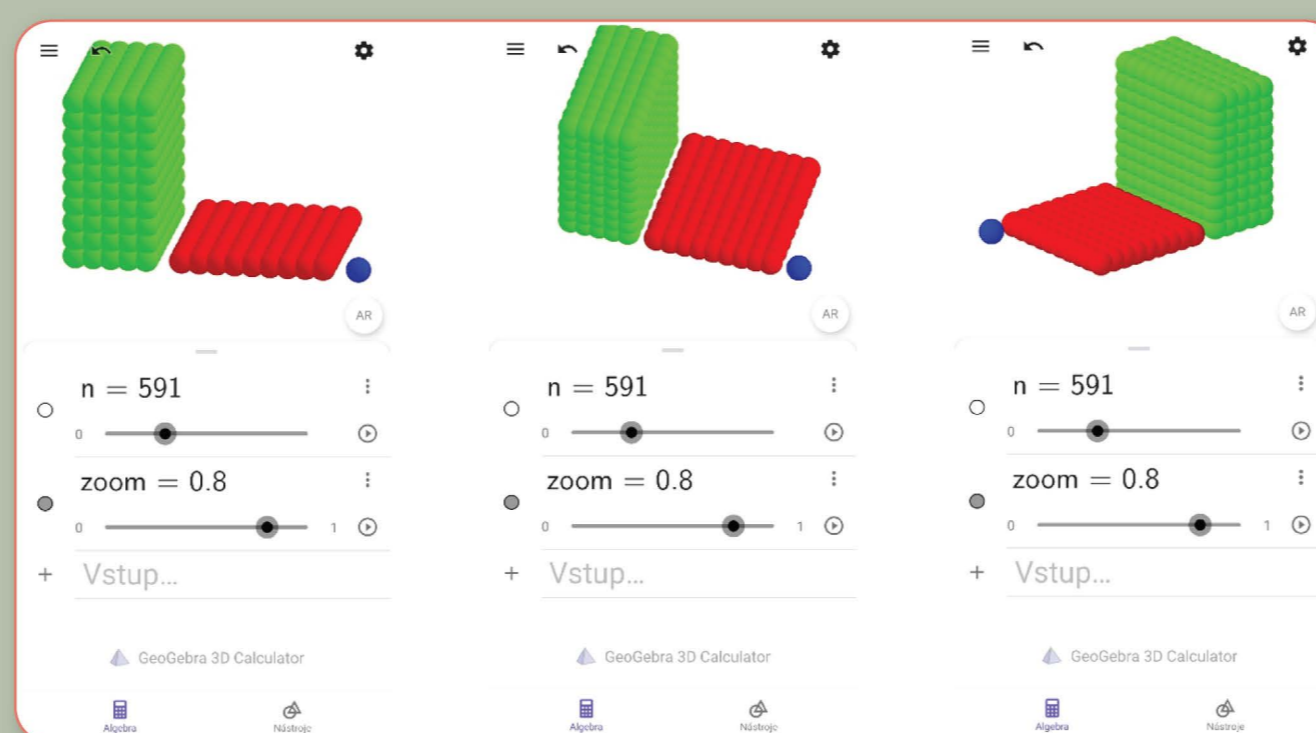
# EDULEARN<sup>23</sup>

## MODELLING OF EXPANDED FORM OF NATURAL NUMBERS

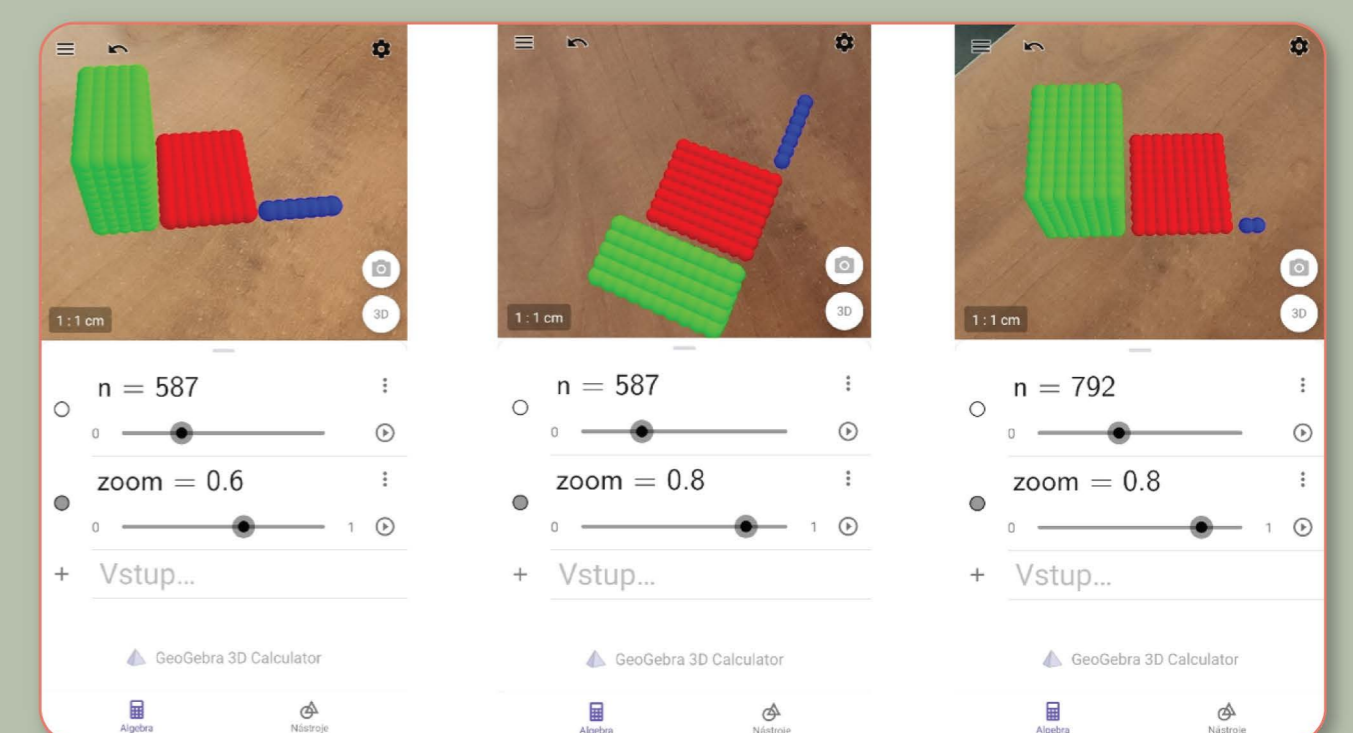
Representation of the expanded form a number - models of different levels of abstraction (enactive, iconic, symbolic).



Model of number 591 – in application GeoGebra 3D Graphing Calculator.



Models of number 591 – in application GeoGebra 3D Graphing Calculator.



Models of natural numbers presented in AR technology.

After entering the code (unique for a specific applet created by the project team), a window is shown on the display of the mobile device. In it, the user changes the input parameters - number size, AR or 3D display mode.

## Augmented Reality technology in education

- means of visualizing mathematical concepts
- creating models of many concepts, at different levels of abstraction
- new approaches to the creation of representations, manipulations, and processes in specific math areas
- meaningful use of new technologies

## References

- [1] J. Hnatová, and A. Hnat, "Rozšířená realita vo vzdelávaní," Osvita u suspišstvo 4., pp.100–108. 2019.
- [2] J. Bruner, The process of education. Oxford, England: Harvard University Press, 1960.
- [3] <https://developers.google.com/ar/devices>

## Acknowledgements

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