





Software-supported development of visuospatial abilities

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Visuospatial abilities play a vital role in many aspects of daily life and higher thinking. They are

- crucial for success in mathematics
- important for mastering everyday life challenges
- a basis for general scientific reasoning
- a good prerequisite for professional success

Visuospatial ability is multi-faceted; we utilized the following aspects:

- "Spatial perception" perceive and grasp spatial relationships between objects
- "Spatial visualization" imagine objects and transform them mentally
- "Imagination of rotation" rotate a figure mentally
- "Spatial relationship" imagine positional relationships between objects in space
- "Spatial orientation" cognitively placing oneself in a spatial situation

When fostering visuospatial abilities, three obstacles can be observed:

• the availability of training materials is usually

- limited and restricted to widespread solids without atypical variations
- commonly used exercises often contain timeconsuming secondary activities like drawing, cutting, or folding
- many tasks are missing verification methods so students cannot comprehend their mistakes







Which chunk fits where?



What does the knight see on his **r**ight and on his **l**eft side?

Mathematikus.de

...helps to overcome these obstacles with four advantages: Mathematikus.de offers stand-alone modules suitable to foster various components of visuospatial ability (1). All tasks focus on the imagination of objects and processes and on the elimination of time-consuming side activities and extensive explanations (2). An animation supplements each task as informative visual feedback. Consequently, users can comprehend whether and why their solution is correct or incorrect (3). The user can control the software with a touch screen. This eliminates a significant



Ride alono



Rolling dice

In this exercise, two picture of dice are depicted. The student must find the two necessary steps to tilt the first dice into the position of the second dice. The student can choose from different instructions, for example "First tilt to the right, then back." After choosing an instruction, the tilting movement is executed and the student can see whether his choice was correct or wrong.



Knight and princess

To prove himself worthy of an audience with the princess, a knight must repair her castle wall, which is missing parts. To fill each gap in the wall, the knight has a choice of several bodies composed of cubes. The selected body moves to the gap, and the student can rotate it. Thus, it is immediately apparent whether the body was selected correctly.



Rotating solids

Given are images of differently oriented colorless figures consisting of cubes. The student's task is to select all colorless solids that are identical to the blue cubic solid. If a student has problems with mentally rotating the cubic solid, i.e., does not immediately recognize the correct solution, he can rotate the blue solid along all three axes.

Nets of cubes

In this module, students must attach a blue square to a given pentomino to form a net of a cube. An animation provides informative feedback. It shows the folding of the square sextuplet. Observing this animation can help students to solve similar problems.





About our current work

Regarding the use of the software, many questions await empirically validated answers. Currently, we are analyzing solution strategies and reasoning patterns for visuospatial tasks which are presented on a screen in 2D. We compare these with students' strategies when working on tasks that are equivalent but presented with physical objects in 3D. Additionally, we are trying to address the question of how much previous experience with 3D tasks is required to grasp the 2D exercises. Finally, we are interested in the way in which students use the implemented informative feedback and to what extent they learn from it.

Pictures:Knight from: Lorenz, J. H. (Ed.) et al. (2007). *Mathematikus 1*. (p. 101). WestermannRubik's Cube from: Pixabay.com by OpenClipart-Vectors

