An Ant, Russian Dolls, Even a Cow Can Help: Understanding Mathematics by Visualizing Structures

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ABSTRACT: To understand and solve mathematical problems involves, among other things, recognizing the underlying abstract structures and patterns. Expert have stored these in the form of internal images and they are available as comparison models for new structures. „Abstract“ means that these structures are not obvious, but must be „seen“ by comparison with the inner images. Novices must therefore first acquire structures in the form of inner images, whereby the necessary learning process can be supported by the expert.

For that the expert must, in a first step, analyze and reflect his own approach, in a relationship that takes cognitive, behavioral, and affective aspects into account. A change of perspective on novices can also be helpful.

In a second step, these structures must be made visible to the novice. For this assistance to be helpful, it must be linked to the knowledge and experience of the three aspects mentioned above.

The difficulties of novice in internalization inner images to be considered here, the analysis of the thoughts of the expert in solving a mathematical problem and the demonstration of invisible thoughts constitute starting points like the “Bottlenecks“ in „Decoding the Disciplines“ (see Middendorf and Pace, 2004). The visualization of the expert's thoughts through images and analogies give the novice a model for his own mental operations.

In the practical examples presented, there are in each case other aspects of the described relationship structure in the foreground:

In the visualization of structures with the help of symbols this is the cognitive aspect. Affective aspects are added in the visualization of structures by the representation of abstract elements on real objects or persons and embedding in a story. Another example shows the visualization of action structures by surprising analogies from everyday life. In these processes an ant, Russian dolls or even a cow can be helpful.

REFERENCES

Middendorf, Joan and Pace, David (2004): Decoding the Disciplines: A Model for Helping Students Learn Disciplinary Ways of Thinking. New Directions for teaching and learning, Vol. 98, pp. 1-12.