Interactive mathematical maps for de-fragmentation

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Transition and fragmentation

Transition problems from school to university in mathematics

Tall (2008) presented a theoretical model which he called the three worlds of mathematics to describe the transition problem from school to university in mathematics. He postulates the difference within the existence of a so-called axiomatic-formal world at university and a separated conceptual-embodied respectively proceptual-symbolic world at school. This model helps to account for some difficulties of many students' transition to university in mathematics, resulting in missing common threads and not knowing connections. Consequently, one of the ideas of our visualization project is the attempt of following "known" conceptual-embodied and proceptual-symbolic truths – where possible through development in time – into the axiomatic-formal world in order to see their genetic connection, the desired and meaningful so-called "golden thread".

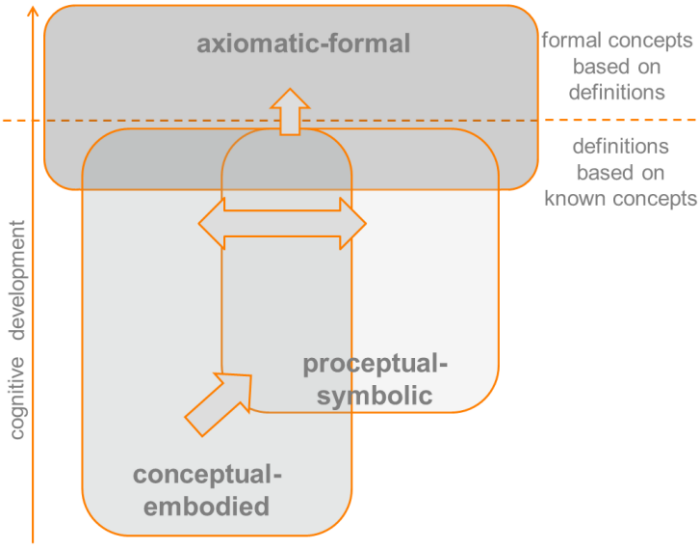

Figure 1: The three worlds of mathematics (Tall, 2008)

Interactive mathematical maps

The concept of "mathematical maps" was introduced by Brandl (2008) as a didactical tool in the form of a virtual tree or net, which shows interrelation between topics (horizontal dimension) as well as the development of a subject matter – starting from an initial problem – in time (vertical dimension). A structural model can be seen in Figure 2. This concept offers several opportunities to foster joined-up thinking and will allow the student to follow the development of an initial problem in time. For example, the visualization in three dimensions allows for an ideal transparency of the interdependencies or the connection of single nodes which additionally offer contents from other platforms by link (Brandl, 2008, pp. 106–109). Another concept, especially for the horizontal orientation, is made by Acevedo (2014) with the "OpenMathMap" which organizes different subjects of

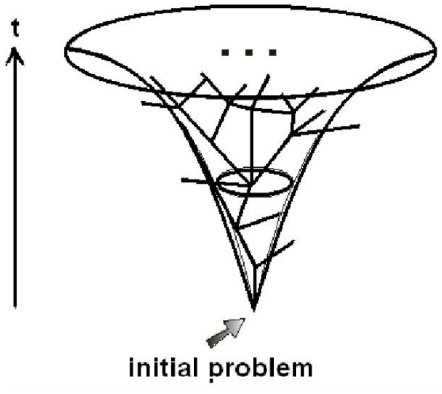

Figure 2: Structural visualisation of the development of an initial problem in time

mathematics by size according to the amount of published papers and by closeness representing the relationship of two subjects (pp. 6–7).

Design-based research methodology

The new teaching format for students in mathematics and mathematics teacher education at the University of Passau will be developed via design-based research methodology. Interactive mathematical maps will be used as a didactical tool to show the interrelationship between different mathematical topics as well as between mathematics at school and at university level, connected by the development of the subject matter in time.

The current status of our work-in-progress is ongoing conceptualization of the teaching format and development of the code for the interactive mathematical maps. Figure 3 shows a screenshot of a first attempt (via JavaScript) to produce content knots which are connected to related content knots by lines in an automatically evolving 3D-visualisation. In order to link the interactive mathematical maps with contents, ILIAS will be used as an e-learning tool (which is the common tool for online courses at the University of Passau). Reasons for the use of e-learning formats are given by constructivism, improvement of quality of teaching, motivation of students and preparation for lifelong learning (Kreidl, 2011, p. 15).

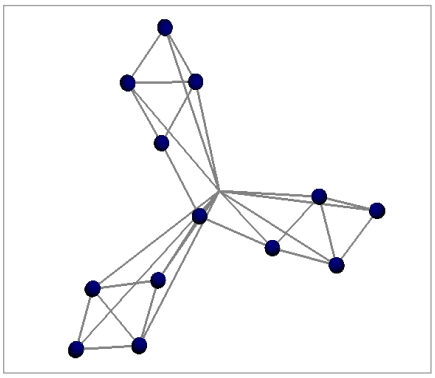

Figure 3: Screenshot of the work-in-progress ICT-tool

The final product will be implemented in mathematics teacher education for (higher) secondary schools (i.e. Gymnasium) to serve for a de-fragmentation process of mathematical contents learned at school and at university. We intend to improve teaching by using e-learning – particularly blended learning – in connection with these interactive mathematical maps. Furthermore, there will be special courses connecting courses in mathematics (first: geometry) and didactic of mathematics (first: didactics of geometry) using the presented ICT-tool in mathematics teacher education.

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