

Teaching Mathematics with Digital Interactive Mathematical Maps (DIMM) for Geometry, Algebra and Calculus

Matthias Brandl¹, Urs Hackstein¹, Mirela Vinerean² and Yvonne Liljekvist²

¹University of Passau, Didactics of Mathematics, Passau, Germany;

Matthias.Brandl@uni-passau.de

²Karlstad University, Department of Mathematics and Computer Science, Karlstad, Sweden

Keywords: Teacher education, defragmentation, design-based research, digital interactive mathematical maps, history of mathematics.

Digital Interactive mathematical maps

In this poster we present results from the design based research and development process of a digital didactical tool connecting secondary and tertiary mathematics education, i.a. by including historical aspects, especially for prospective mathematics teachers: Digital Interactive Mathematical Maps (DIMM). Amongst others, new findings from additional maps on algebra and calculus are presented.

Making connections to context and using scaffoldings in a holistic teaching strategy in order to address the double discontinuity via defragmentation

The DIMM (freely at <https://math-map.fim.uni-passau.de>) aim to address the “double discontinuity” (Klein, 1924/2016) of teacher education via defragmentation by making connections to context and using scaffoldings in a holistic teaching strategy. The first discontinuity describes the problems at the second-tertiary transition which has received much attention, partly because of high drop-out rates of students. The second discontinuity addresses problems when transitioning back to school. A major underlying reason is the different appearance of mathematics at school and at university resulting in students being unable to relate them to each other. Winsløw and Grønbaek (2014) showed that this is still a relevant problem in our current education system. In general, a holistic perspective on the transition problem is sought or proposed (see, e.g., Gueudet et al., 2016).

Results from the implementation and evaluation of DIMM so far

The concept of DIMM was first time presented in Brandl (2009) as a supportive didactic tool that shows both connections between mathematical discoveries (horizontal dimension) and the historical development of a mathematical content - starting from an initial problem - in time (vertical dimension). Furthermore, historical and scientific contextual information are included as a scaffolding for the integration of new mathematical content. The DIMM went through several research cycles and have been applied in mathematics education courses cooperatively designed by university mathematics lecturers and researchers in mathematics education at different universities in the field of geometry (Datzmann & Brandl, 2019; Przybilla et al., 2022) and now in calculus; first results of the latter will be presented in the poster, too.

Overall, the results of evaluation show that the implemented parts of the map are perceived as useful and mostly easy to use, e.g.:

The interactive map gave me a good and easy understanding of the development of the mathematical analysis. It showed well and simply the order in which the different people contributed and the connection between their discoveries. (Student 18, Quiz 2, Question 1)

Only minor shortcomings in the functionalities and the design (e.g., the fact that the maps are only available in English and German up to now) became apparent, which will have to be adjusted in the next design cycle. Furthermore, the use of the map within the courses seems to promote favorable beliefs regarding the nature of mathematics (Vinerean et al., 2023).

References

- Brandl, M. (2009). The vibrating string – an initial problem for modern mathematics; historical and didactical aspects. In I. Witzke (Ed.), *Mathematical Practice and Development throughout History: Proceedings of the 18th Novembertagung on the History, Philosophy and Didactics of Mathematics* (pp. 95–114). Logos Verlag. <https://www.logos-verlag.de/cgi-bin/engbuchmid?isbn=1668&lng=eng&id>
- Datzmann, A., & Brandl, M. (2019). Evaluation of a connecting teaching format in teacher education. In U. T. Jankvist, M. van den Heuvel-Panhuizen & M. Veldhuis (Eds.), *Proceedings of the Eleventh Congress of the European Society for Research in Mathematics Education (CERME11)* (pp. 2462–2463). Freudenthal Institute, Utrecht University and ERME. <https://hal.archives-ouvertes.fr/hal-02422599>
- Gueudet, G., Bosch, M., diSessa, A., Kwon, O.-N., & Verschaffel, L. (2016). *Transitions in mathematics education*. Springer. <https://doi.org/10.1007/978-3-319-31622-2>
- Klein, F. (2016). *Elementary Mathematics from higher standpoint. Volume I: Arithmetic Algebra Analysis*. (G. Schubring, Trans.) Springer. (Original work published 1924). <https://doi.org/10.1007/978-3-662-49442-4>
- Przybilla, J., Brandl, M., Vinerean, M., & Liljekvist, Y. (2022). Digital mathematical maps – results from iterative research cycles. In J. Hodgen, E. Geraniou, G. Bolondi & F. Ferretti. (Eds.), *Proceedings of the Twelfth Congress of the European Society for Research in Mathematics Education (CERME12)* (pp. 4793–4800). Free University of Bozen-Bolzano and ERME. <https://hal.archives-ouvertes.fr/hal-03754749/>
- Vinerean, M., Brandl, M., & Liljekvist, Y. (2023). Promoting favourable beliefs of prospective math teachers concerning the nature of mathematics by using Interactive Mathematical Maps. In M. Trigueros, B. Barquero, R. Hochmuth & J. Peters (Eds.), *Proceedings of the Fourth Conference of the International Network for Didactic Research in University Mathematics (INDRUM 2022)* (pp. 574–575). University of Hannover and INDRUM. https://hal.science/INDRUM2022/public/INDRUM2022_Proceedings.pdf
- Winsløw, C., & Grønæk, N. (2014). Klein's double discontinuity revisited: contemporary challenges for universities preparing teachers to teach calculus. *Recherches en Didactique des Mathématiques*, 34(1), (pp. 59–86). <https://revue-rdm.com/2014/kleins-double-discontinuity-revisited/>