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MathCityMap and supporting learners with exceptional difficulties in learning mathematics

Philipp Larmann and Matthias Ludwig

Goethe University Frankfurt a.M., IDMI MATIS I, Germany; larmann@math.uni-frankfurt.de;
ludwig@math.uni-frankfurt.de

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Exceptional difficulties in learning mathematics

The term “exceptional difficulties in learning mathematics” is used to describe serious and persistent difficulties in learning mathematics (Gaidoschik et al., 2021). It therefore follows the more widely known terminology of “mathematical learning difficulties” (Mazzocco, 2008). This circumscription, which captures both diagnosed (e.g., dyscalculia) and undiagnosed problems on the learners' side, is used for two central reasons. First, to avoid a one-sided view that attributes the causes of difficulties only to individual factors. Second, the plural “difficulties” is intended to indicate that a wide range of problems can manifest themselves in a variety of forms in an individual learner (Gaidoschik et al., 2021). Typically, exceptional difficulties are found in the three central mathematical basic skills: understanding natural numbers, understanding the decimal place-value system, and understanding arithmetic operations. If those deficits are too serious, subsequent topics (e.g., decimals, algebra, etc.) can hardly be understood and, in the best case, can only be learnt by rote (Prediger et al., 2019).

MathCityMap – theoretical background and concept

The idea of mathematical learning trails already emerged in the 1980s. A math trail is a walk on which mathematical tasks are implemented at various interesting objects along the way in order to make mathematics directly experienceable in the real world (Shoaf et al., 2004). The EIS principle according to Bruner, which has already proven itself in special and regular schools alike (Ozdem-Yilmaz & Bilican, 2020), can be mentioned as the basic theoretical idea of this concept. On the trails, learners gain important mathematical experiences at different levels of representation of mathematics. They work enactively on real objects (e.g., measuring objects with tools), iconically (e.g., drawing, modelling the objects), and symbolically (e.g., calculations). Especially lower-performing learners benefit from this type of outdoor learning and can better understand content and procedures based on the concretely experienced examples (Buchholtz & Armbrust, 2018). The MathCityMap project has succeeded in developing this original concept further and bringing it into the digital age as well as embedding it in school contexts. Tasks are now found via GPS data in an app, which already provides specific and graded help. On the tasks themselves, the learners work in small groups, whereby they can stay in contact with the teacher via a chat function. The solutions found can already be checked on site in the app, where a detailed sample solution can be retrieved (Gurjanow et al., 2017).

Research question

From the theoretical background on which the concept of MathCityMap is based and its potential for exceptional difficulties, the following research question arises: How can MathCityMap be used to support students with exceptional difficulties in learning mathematics? This question is supported by

criteria of successful support, which MathCityMap seems to fulfil. For example, learning on MathCityMap tasks always happens in discourse with other learners, and on learning objects that make natural differentiation possible (Gaidoschik et al., 2021, p. 12). An examination of the suitability is to be carried out with this investigation for the first time.

Outlook

In order to answer this question, a qualitative study will be conducted within the framework of the support project Mathe.Kind, which will be implemented at Goethe University Frankfurt in 2022 and is founded by the researchers that are also working on MathCityMap. Here, students with exceptional difficulties in learning mathematics will be individually supported in reducing their deficits and building up their competencies. MathCityMap will be used as a learning environment in different support sessions. Afterwards, it will be checked if certain difficulties could be reduced. For this purpose, task-supported interviews will be conducted with the students before and after the support sessions. To increase the accessibility of MathCityMap, the app will be equipped with a read-aloud function and an “easy language” setting option before the study is conducted.

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