MOBILE LEARNING OUTSIDE THE CLASSROOM WITH MATHCITYMAP

Simone Jablonski[1,2], Simon Barlovits[1], Iwan Gurjanow[1], Philipp Larmann[1], Matthias Ludwig[1], Deng-Xin Ken Oehler[1] and Sina Wetzel[1]
[1]Goethe University Frankfurt, Germany
[2]University Koblenz, Germany

Abstract. Discovering mathematics in one's own environment inspires students. Numerous everyday objects offer potentials for posing interesting and motivating measuring tasks. To organize the mathematics lesson outdoors, teachers can create so-called math trails in their environment using the MathCityMap system: a web portal and a smartphone app are available to prepare and conduct a math trail. Equipped with the app and measuring tools, the students work in small groups on the object side. Hereby, the MathCityMap app supports the independent and collaborative learning of students offering hints and direct answer validation. In the following paper, the components of MathCityMap are presented.

Key words: MathCityMap, math trails, mobile learning.

MATH TRAILS AS AN INTERACTIVE LEARNING FORMAT

Our environment is full of mathematics. Such experiences can be realized with the use of math trails focusing on mathematical problems about real-life objects (Shoaf et al., 2004). Equipped by a map indicating where the tasks are located and measuring tools such as a folding ruler and measuring tape, students work on these mathematical problems outdoors. The goal of a math trails becomes obvious: doing math actively on site of an object and to discover mathematics in the real world (cf. Shoaf et al., 2004).

In an educational context, students can be sent on a theme-based trail in small groups (Barlovits et al., 2020). The tasks or stations of a math trail are completed at an individual pace and by means of mathematical activities, i.e. measuring, calculating and counting. This collaborative and interactive character can be supported by the use of digital tools: The MathCityMap system uses two technical components - a web portal and a smartphone app. The web portal supports the preparation, implementation and follow-up activities of math trails from a teacher's perspective. The use of the smartphone targets the reality of students' digital lives and supports them in their individual working and solution process (see in addition Ludwig & Jablonski, 2021).

THE MATHCITYMAP SYSTEM

First Component: The web portal

In the MathCityMap web portal (https://mathcitymap.eu/de/portal/; see Figure 1), teachers can select contents from a database of over 1.700 public math trails and 15.500 tasks worldwide. Furthermore, own tasks and math trails – adapted for the needs of the individual learning group – can be created.

Jablonski, S., Barlovits, S., Gurjanow, I., Larmann, P., Ludwig, M., Oehler, D.-X. K., & Wetzel, S. (2023). Mobile Learning Outside the Classroom with MathCityMap. In M. Ludwig, S. Barlovits, A. Caldeira, & A. Moura (Eds.), *Research On STEM Education in the Digital Age. Proceedings of the ROSEDA Conference* (pp. 193–196). WTM. https://doi.org/10.37626/GA9783959872522.0.24

The tasks are positioned at the location of the object with the help of GPS data which can be extracted automatically from an uploaded image. Besides an image of the object, a complete task comprises hints that students can call up when needed, a sample solution, as well as required measuring tools. In order to be able to validate the solution immediately, the answer formats multiple-choice, interval (correct, mediocre or wrong range) exact solution, vector and fill-in-the-banks are available. Especially in measurement tasks, where small inaccuracies in the measurement should not lead to a wrong result, the interval is recommended as a solution format. With the help of support tasks, complex tasks can be broken down into smaller task units. If, for example, several measurements and calculations are necessary to solve a task, the learner can be guided in small steps and each step is validated separately. The teacher can decide whether the support tasks are mandatory or optional.

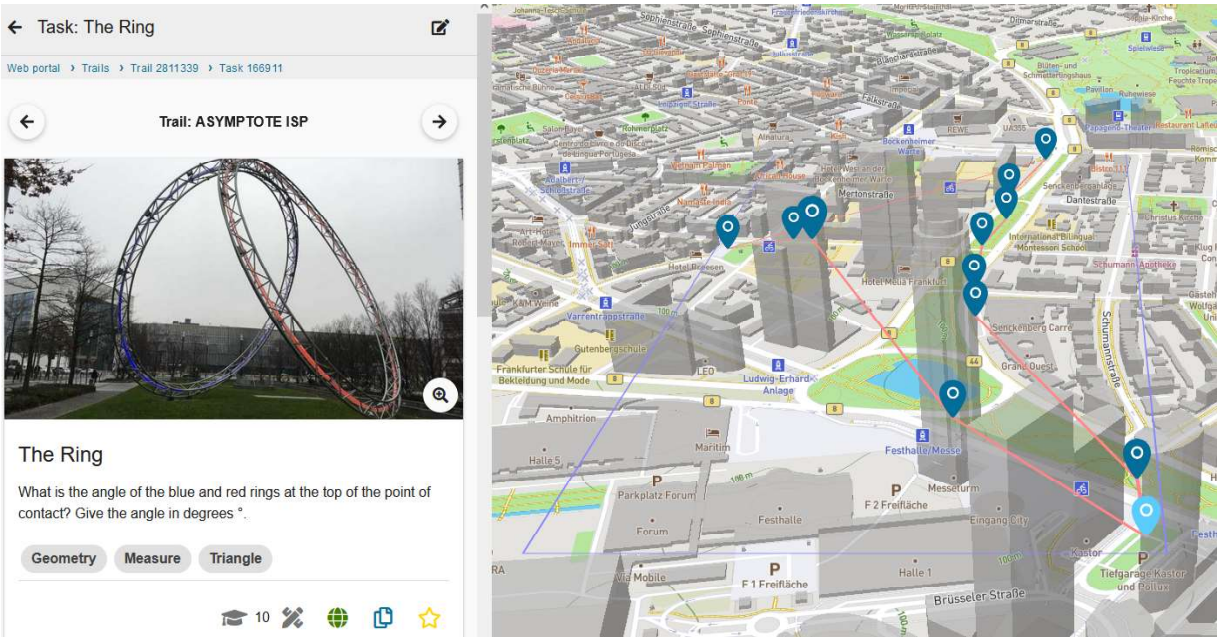

Figure 1: The task “The Ring”, which is part of a math trail, as viewed in the MathCityMap web portal.

Second Component: The smartphone app

The corresponding smartphone app MathCityMap is freely available for Android and iOS (see Figure 2). It supports the students in working on a math trail created by the teacher in the web portal. The app shows the student’s own position and the location of the tasks on a map. Furthermore, the tasks previously formulated by the teacher can be called up, including the hints. For the answer validation, the app gives an immediate feedback on an entered result. In addition, students can view the sample solution after ending a task. After completing a task, the app automatically leads a student to the next task.

All functionalities of the app combined support the independent work of small groups while completing a math trail. In particular, the fact that the teacher cannot be present at all math trail tasks at the same time makes the necessity of the app as a digital support tool clear. In

order for the teacher to keep track of what is going on, the Digital Classroom feature of MathCityMap provides additional support.

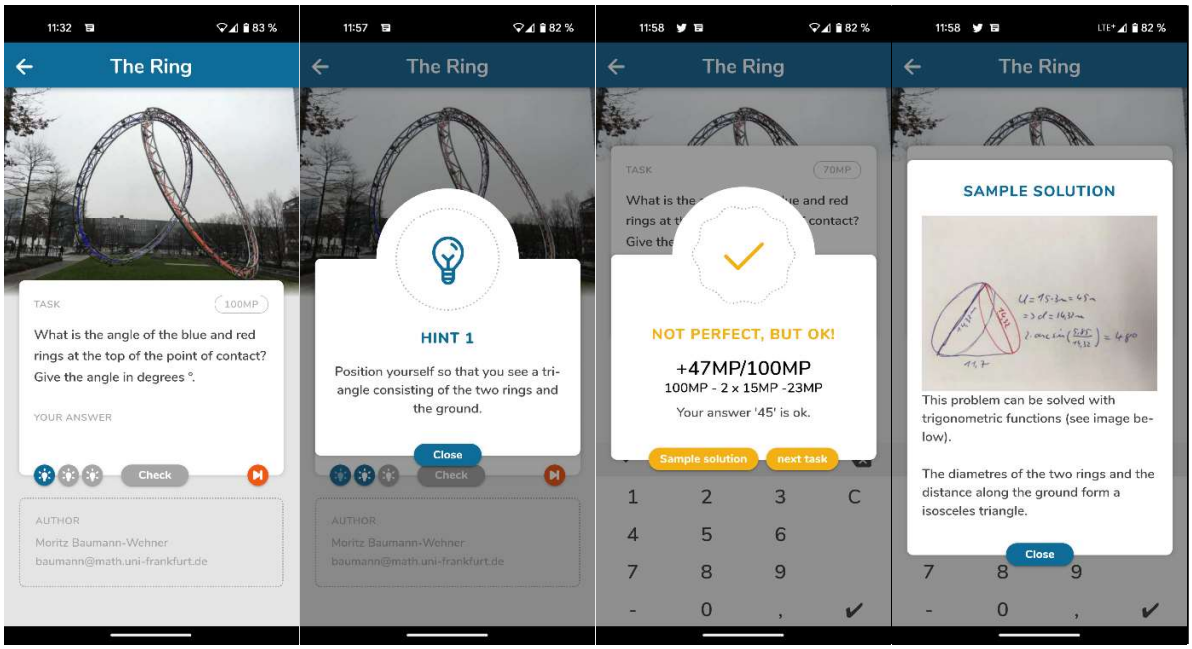

Figure 2: The task "The Ring" displayed in the MathCityMap app: task formulation, hints, immediate app feedback and sample solution (screens from left to right).

Third Component: The Digital Classroom

Within the so-called Digital Classroom, an optional and temporary digital learning environment in the web portal, the teacher can use the following additional functions to orchestrate the students' working process on a math trail:

- Chat function: The teacher can communicate with selected groups or all students in case of queries and problems. The groups can also write to the teacher. Hereby, it is possible to send text, images and audio recordings.
- Tracking Tool: In this section, the teacher can track the progress of each group as they walk the trail, see their current positions and walking paths as well as their input on individual tasks (see Figure 3).
- E-portfolio: The entered results of each group are still available afterwards. From this, procedures and also error types can be identified which can be used for diagnostic measures and for further follow-up activities.

The Digital Classroom also supports general organization by automatically assigning a starting task to each group, if required. If the number of tasks is twice as large as the number of small groups, the system ensures that one task is placed between each two groups to accommodate different work places. In general, no personal data of the students is stored and processed when using the Digital Classroom, so that the tool is in line with European data protection standards.

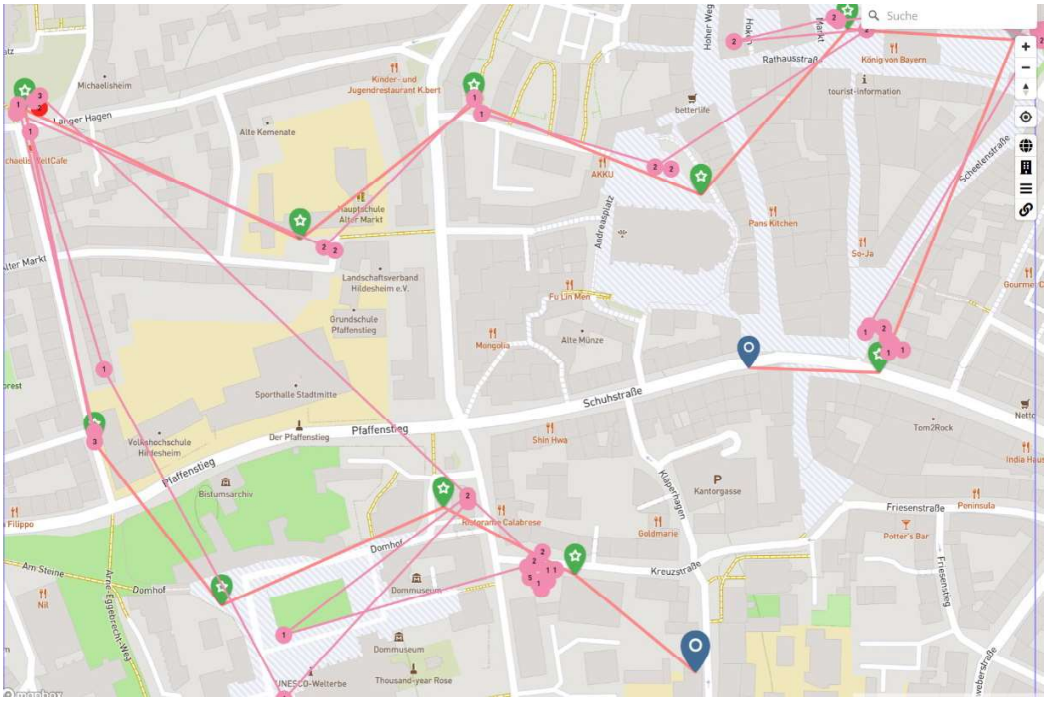

Figure 3: Tracking function in the digital classroom.

OUTLOOK: THE WORKSHOP

Within the proposed workshop, the participants get to know the system from a student's and a teacher's perspective. After a short introduction on outdoor learning and math trails, the participants experience a math trail supported by the MathCityMap app. Subsequently, the participants share their experience with each other.

The second part of the seminar focuses on the teacher's perspective and starts with an introduction of the web portal and the presentation of criteria for meaningful outdoor math tasks. With this basis, the participants create their own tasks in the MathCityMap web portal. The workshop ends with a discussion on the potentials of outdoor mathematics and the benefits of supporting this outdoor experiences by the help of mobile learning.

As preparation for the workshop, the participants should download the MathCityMap app and register in the MathCityMap web portal. They should participate with their computer and have a smartphone/tablet on site. Let's join the community!

References

Barlovits, S., Baumann-Wehner, M., & Ludwig, M. (2020). Curricular learning with MathCityMap: creating theme-based math trails. In A. Donevska-Todorova, E. Faggiano, J. Trgalova, Z. Lavicza, R. Weinhandl, A. Clark-Wilson, & H.-G. Weigand (Eds.), *Mathematics Education in the Digital Age (MEDA) – Proceedings* (pp. 143–150). ERME & Johannes Kepler University.

Ludwig, M., & Jablonski, S. (2021). Step by Step – Simplifying and Mathematizing the Real World with MathCityMap. *Quadrante, 30*(2), 242–268.

Shoaf, M. M., Pollak, H., & Schneider, J. (2004). *Math trails*. COMAP.