FORMATIVE ASSESSMENT IN ONLINE COURSE – IDEAS AND EXPERIENCES

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Abstract. *Formative assessment is known for its positive effects on learning outcomes. However, there is still a need for research on the use and successful implementation of this approach. In this article, a university online course about math trails for pre-service teachers is presented, who took the key strategies of formative assessment into account. The concept and the implementation of the course will be presented especially with regard to these key strategies showing how formative assessment can be used and what potential lies in it.*

Key words: Formative assessment, math trail, online course.

THEORETIVAL BACKGROUND OF FORMATIVE ASSESSMENT

When planning a lesson or a course - e.g. for students at school or at university - the didactical concept of constructive alignment has to be considered to coordinate teaching and learning methods, forms of examination and desired learning goals. Therefore, three aspects must be considered (cf. Biggs & Tang, 1999; see also Figure 1):

- Learning objectives: What should the student know or be able to do?
- Learning activities: How does the student reach the final level?
- Assessment: How are knowledge and abilities measured?

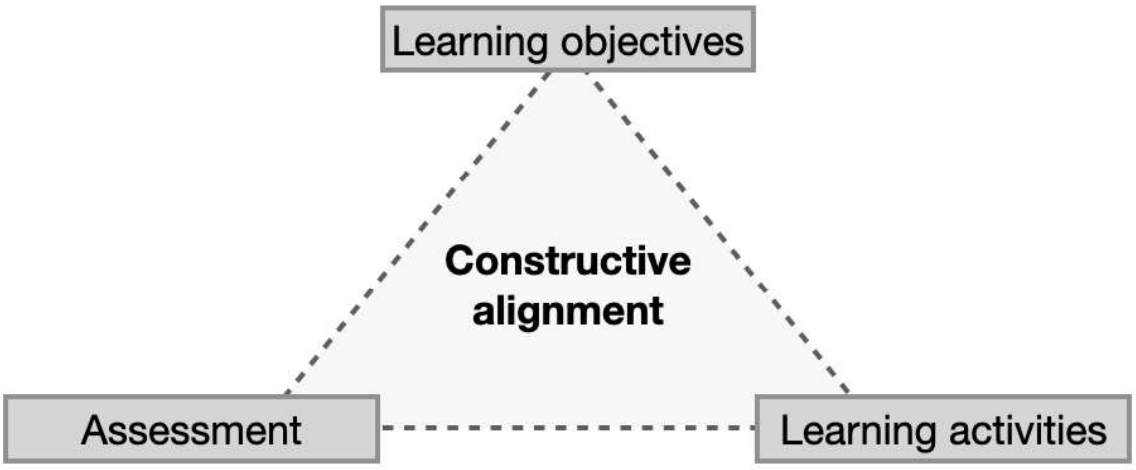

Figure 1: Constructive Alignment based on Biggs & Tang (1999).

With regard to the aspect of assessment, Gerick, Sommer & Zimmermann (2018) distinguish based on Schaper and colleagues (2012) and Knight (2001) result-oriented and process-oriented or summative and formative assessment.

Geisen, M. & Zender, J. (2023). Formative Assessment in Online Course – Ideas and Experiences. In M. Ludwig, S. Barlovits, A. Caldeira, & A. Moura (Eds.), *Research On STEM Education in the Digital Age. Proceedings of the ROSEDA Conference* (pp. 25–32). WTM. https://doi.org/10.37626/GA9783959872522.0.03

Summative assessment is mostly about grading at the end of a learning unit at school or at the end of a course at university, for example, through a written or oral exam (cf. Sadler, 1989; Brookhart, 2010; Cizek, 2010; Maier, 2010; Gikandi, Morrow & Davis, 2011). Formative assessment, on the other hand, takes place parallel to the learning unit or course to support the learning process and to improve individual learning (cf. Brookhart, 2010; Cizek, 2010; Maier, 2010; Gikandi, Morrow & Davis, 2011). Further, formative assessment enables teachers to adapt learning opportunities to the needs of the respective learners (cf. Black & Wiliam, 2008). Wiliam and Thompson (2008) describe five key strategies of formative assessment in terms of school learning (see Figure 2):

	Where the learner is going	Where the learner is right now	How to get there
Teacher	Clarifying learning intentions and criteria for success	Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding	Providing feedback that moves learners forward
Peer	Understanding and sharing learning intentions and criteria for success	Activating students as instructional resources for one another	
Learner	Understanding learning intentions and criteria for success	Activating students as the owners of their own learning	

Figure 2: Aspects of formative assessment based on Black & Wiliam (2008).

Concerning formative assessment at school, Schütze, Souvignier and Hasselhorn (2018) identify a need for research on the use and successful implementation of this approach, but this aspect should also be explored regarding university education. For this reason, this article focuses on formative assessment to provide new ideas and experiences in terms of an online course in mathematics for pre-service teachers at university regarding the key strategies described above.

DISCOVER MATHEMATICS OUTSIDE WITH MATHCITYMAP

Mathematics can be discovered everywhere, and extracurricular learning locations can be a useful addition to regular mathematics lessons at school and enrich them (cf. Scherer & Rasfeld, 2010), for example, concerning primary experiences or active construction processes (cf. Sauerborn & Brühne, 2009). As part of math lessons, mathematical trails can be implemented (cf. Shoaf, Pollak & Schneider, 2004), which means that mathematics can be discovered outside at different locations by working on tasks where it is necessary to collect data at the respective locations (cf. Ludwig & Jablonski, 2020, S. 29). For example, the area of objects outside can be calculated, such as the back of a skate ramp (see Figure 3).

For a long time mathematics trails have been used and only the motivational aspects were researched (Gurjanow et al., 2020), but they held the potential to also positively influence the learning outcome (Cahyono, 2018, Zender, 2019). To get the most out of a math trail, the MathCityMap project was founded. In the context of the MathCityMap project such

mathematics trails were connected to new technologies such as smartphones and the Internet (cf. Jesberg & Ludwig, 2012), and the MathCityMap app (short MCM app) was developed including a web portal and an app for creating and implementing math trails (cf. Ludwig & Jablonski, 2020). In this way, not only the above-described advantages of discovering mathematics outside are used, but more applications and references to reality can also be taken into account.

Figure 3: Picture by Anna Albrecht.

FORMATIVE ASSESSMENT AS PART OF A MATH TRAIL COURSE FOR PRE-SERVICE TEACHERS

Classification and design of the course

In the summer of 2021, two online courses about mathematics trails were offered for pre-service teacher students at the University of Koblenz-Landau (cf. Geisen & Zender, 2022). The students taking part into this course all lived in the area of Koblenz, which made it possible for them to meet outside in small groups. This is based on a course developed by Ludwig, Gurjanow and Barlovits at the University of Frankfurt (part of the EU-Erasmus+ project MoMaTrE), which was adapted by adding new elements. Besides, the course was held entirely digitally. Forty-five each took part in both courses, so ninety students of elementary school mathematics in total, most of which were female.

The main goal of the course was to enable the students to create mathematics trails. Therefore the course was subdivided into the following learning units:

- The students developed the theoretical background for extracurricular learning in mathematics in small groups (e.g. Scherer & Rasfeld, 2010; Sitter, 2019).
- In this small groups, the students developed the theoretical consideration of relevant general didactic topics in connection to math trails (e.g. digital media, group work). And every student took a photo of an extracurricular learning place for mathematics that can be connected to any other subject.

- The students developed relevant mathematic didactic topics in small groups (e.g. task design, modelling, measurement).
- Every student did a mathematical walk through her/his neighbourhood and photographed objects where mathematics can be discovered.
- The lecturer introduced the project MathCityMap and the MCM app.
- The students walked a mathematics trail with the MCM app selected by the lecturer in small groups and worked on tasks outside so that they could gain experience. Afterwards, they worked on two reflection tasks in this regard: On the one hand, they reflected on what they liked and did not like. On the other hand, they chose the two most difficult tasks of the mathematics trail and analysed their own hurdles and possible difficulties of learners.
- The students used the MCM app and developed mathematical tasks for three objects.

All tasks and pictures had to be handed in by using a Learning Management System. At the end of the course, asynchronous oral exams were held (cf. Geisen & Zender, 2022).

Concerning the methodical design, the students had to form small groups and meet in person (outside) at the beginning of the course in order to work on all the above-mentioned assignments together (see below). In addition, working in small groups should demonstrate the positive aspects of cooperative collaboration and have a lasting impact on the students. Especially with regard to the relevance of the cooperation of teachers in terms of their professionalisation and further development of competencies and convictions (e.g. Arndt & Werning, 2013) as well as concerning a relief function (e.g. Trapp & Ehlscheid, 2018). Every group work was reviewed by other groups of students and by the lecturer. In the next section, examples of such reviews were described as well as drawing the connection to the key strategies of formative assessment.

Implementation of formative assessment

At the beginning of a course, it should be self-evident to explain, share and understand the learning goals. Therefore, all goals, especially the main goal to enable the students to create mathematics trails, were of course communicated throughout the seminar. However, the focus of this article is on the other key strategies (recording the (individual) learning status through discussions, tasks or questions, giving helpful feedback, activating learners as being responsible for their learning process and activating learners as resources of learning for each other) which are shown in the following illustration and are interwoven:

The students worked out relevant mathematic didactic topics independently in small groups to create a five-minute podcast (a short audio play). For this, they each chose a topic from various given topics, whereupon two other groups reviewed each podcast. In addition, each group formulated three questions about their topic, the answers to which were used as a work assignment for the other groups.

After the theoretical input, the students were asked to take a mathematical walk through their neighbourhood and photograph objects where they could discover mathematics. The students made their photographs available within the framework of the learning management system OLAT, and the other students were supposed to reflect on the connection between mathematics, the depicted object and a real-world reference on the one

hand and possible tasks about the posted photographs on the other hand. One student photographed various objects on a playground, which, among other things, refer to the geometric shape of the triangle (see Figure 4). In this respect, discussion occasions are, for example, the use and function of different types of triangles (e.g. acute and obtuse triangles) as well as the change of the angles of the triangle in relation to the slide experience.

Figure 4: Picture series "Doing mathematics outside, ideas for the playground" by Lea Nisius.

As part of the last practical work assignment, the students registered for the MCM app and developed mathematical proposals for three different objects outside, which the seminar lecturer reviewed online via the MCM Webortal and the review function. After a revision phase, a new trail was generated with these nine objects (three objects each from the three students in the small group), again reviewed by another small group by trying the trail at the site and then again online by the lecturer.

Quotes from the evaluation at the end of the course:

- "I found the exchange about the results and the access to the results of the other students very helpful, because I had such a repertoire of possibilities and solutions. In addition, it is helpful that materials are always accessible."
- "All units of the seminar built on each other. I also found the proportion of theoretical knowledge and practical application very balanced. We received prompt individual feedback on the tasks with additional suggestions. Despite the purely digital teaching, we were able to exchange ideas with each other and gain practical experience. The chosen goal of a completed trail was very motivating to deal with the content in depth, as it had a purpose."
- "The transparency and the common thread that ran through the event are to be commended. I was pleased with the feedback on the tasks handed in."
- "I was very pleased to receive feedback on my submissions. Unfortunately, that is only the exception and not the rule."
- "The structure of the seminar was very good, as you were introduced step by step to the creation of your own math trail."

Judged by the voices of the students, the formative assessment worked out well. As they state, the learning goals were transparent, clear, and therefore motivating. Throughout the intense work in groups of three, the students had discussions and exchange and they recognize the others as resources, they have been activated to give and receive peer reviews of their tasks. In addition, there was the feedback from the expert. All feedback were helpful, and the students even liked it to get feedback. They had joy in learning.

CONCLUSION

The course specifically aimed at the questions where the learner is right now and how the learner reaches the goal. These questions are identified as two aspects of formative assessment (cf. Black & Wiliam, 2008). Giving feedback was the most essential part of the seminar. Feedback came from peers or/and the lecturer as an expert in the field. Since every task had to be handed in, the lecturer was aware of the difficulties and problems of the students, and so the students could be addressed to a special degree. The knowledge about this also influenced the process of the learning-accompanying feedback. The format of an online course opened up the possibilities and showed the needs of these intensive review processes, especially by the lecturer. As the students formed groups, they were responsible for the learning process of their group. Thus, they were also responsible for their own. Peer Assessment is an integral part of the seminar. In many cases, the peers correct the others in the first step, and in the second step, the lecturer gives feedback. Also, working in groups of three the whole time does help to recognize the others as resources for learning. Furthermore it should be mentioned, that the MCM web portal provides good opportunities for feedback, such as creating groups to share, work and comment on common tasks for peers and the review process to comment on handed-in tasks by the expert.

From the point of view of the lecturer, formative assessment was in the presented course a good opportunity to accompany and support the students. It can be assumed that the large amount of feedback during the semester also helped the students with the exam at the end. Overall, it can be promising, where the implementation is of course demanding and complex (cf. Schütze, Souvignier & Hasselhorn, 2018).

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