



Challenges in Mathematics Learning at the University: An Activity to Motivate Students and Promote Self-awareness

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Abstract. Math anxiety is always just around the corner. At the university, it makes students continuously postpone the Calculus exam, leading them into a vicious circle of low confidence and poor performance. To get out of this situation, students need to be motivated and involved. They also need to master metacognitive strategies that can support their learning process. In this paper, we present a digital activity entitled *Advent Calendar*, focused on storytelling and proposed through the logic of spacing. The aim is to increase students' motivation and self-awareness, but also to obtain learning analytics useful to monitor progress and solve any possible weaknesses with appropriate feedback. The activity was proposed using the tools offered by the Learning Management System (LMS) Moodle. It was tested in three university courses at two Italian universities, the University of Milan and the Polytechnic University of Turin, with students' active participation. This participation had a high impact on the results of the final examination. Feedback demonstrated positive feelings and good results in the motivation process, while the analytics showed a continuous approach to the study of mathematics.

Keywords: Teaching mathematics · Learning strategies · Educational technology

1 Introduction

The main purpose of general scientific degrees' Calculus courses is to introduce students to the scientific method of analysis, providing a suitable language and useful skills in order to effectively face other disciplinary courses. Unfortunately, this does not happen frequently. Many students see the Calculus exam as a stumbling block and try to postpone it as much as possible. This negative mindset can quickly turn into a cycle of low confidence, lower motivation, and poor performance [1, 2]. Math anxiety is always just around the corner [3]. The impact of the COVID-19 pandemic on education, with the distinctive rise of e-learning and digital platforms, has added to this emotional stress and forced teachers to quickly develop new teaching strategies.

In this framework, designing preliminary actions aimed at fostering students' motivation and self-awareness is an essential challenge. Literature shows that students with higher learning motivation “achieve significantly higher test scores, enjoy learning more, have more positive self-concepts, make greater use of deep learning strategies and engage to a greater extent in autonomous self-regulated learning” [4; see also 5, 6].

Storytelling can support motivation. Its application to mathematics gives a concrete form and a familiar connotation to abstract concepts, involving emotions and imagination at the same time. “A story tends to have more depth than a simple example” [7]. Several authors have investigated the benefits of storytelling as a powerful medium for teaching and learning mathematics [8–10]. A narrative scenario downplays disciplinary topics and leads students to tackle challenging problems that they would seldom face in a more serious context. Stories and their characters can involve students and provide a structure for remembering concepts, and creating vivid mental images [7, 11]. Bruner underlined that “many scientific and mathematical hypotheses start their lives as little stories or metaphors” [12].

Metacognition can strengthen students' self-awareness. It is essential to focus on the ways in which students manage their study, teaching them appropriate strategies to monitor their own learning. One of the most effective metacognitive control strategies is *spacing*. Spacing consists of spreading out study time across a sufficiently long period in order to produce a more long-lasting learning [13]. It requires planning, however, and students are often unable to do that.

In a digital environment, learning analytics are essential. Tools provided by Learning Management Systems (LMS)—such as Canva, Moodle and Blackboard—make it easy to track students' progress. Teachers can provide global or individual feedback and act promptly on any potential weaknesses. In addition, they can monitor students' participation in the course activities, especially if it is delivered entirely online. In the university context, learning analytics are a powerful resource in view of the final exam.

This paper describes the *Advent Calendar*, a non-conventional digital learning activity designed to work on motivation and awareness (see *Activity Design & Implementation*). We present its features (see *Activity Features*), we provide some examples (see *Unwrapping the Gifts*), and we comment on the results of a pilot test (see *Results*).

2 Activity Design and Implementation

The *Advent Calendar* activity is inspired by the logic of the special calendar used to count the days until Christmas. It combines storytelling and spacing. Every day, students carry out a Christmas-themed mathematical exercise: Santa Claus, the elves and the reindeer are facing problems that can be solved by exploiting suitable mathematics tools introduced during a Calculus' course.

The activity can be carried out using Moodle assignments, along with a Google Drawings file. Google Drawings makes it possible to create an interactive image of the *Advent Calendar*, which can be embedded in a Moodle page (see Fig. 1). Each gift box is

linked to the page of a single exercise hosted inside a Moodle assignment¹. The Moodle assignment's *restrict access* feature can be used in order to allow students to enter and submit their exercise only on the corresponding day². The first student who submits the correct solution is awarded with his/her name on the corresponding calendar's gift box.

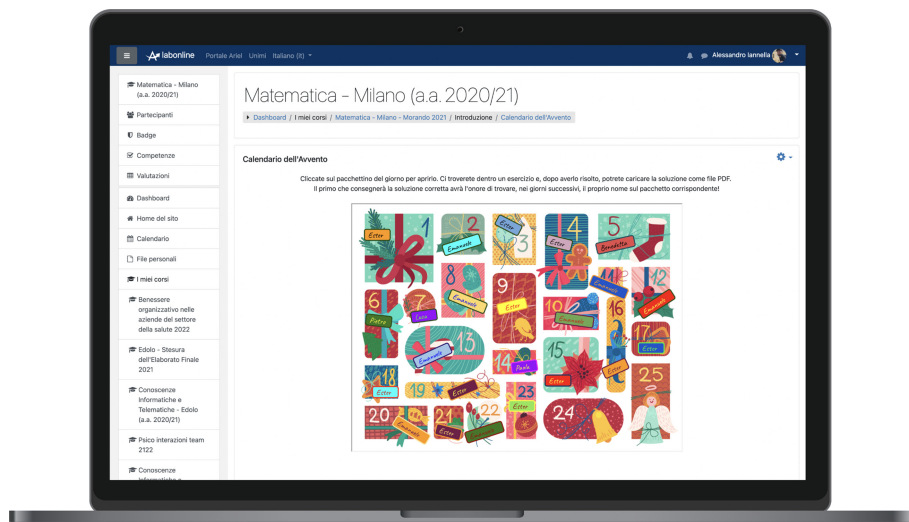


Fig. 1. The *Advent Calendar* activity inside a Moodle page. Each gift box is linked to an exercise.

In order to make the activity effective, it is crucial to give students personalised feedback on their answers or to publish a complete solution to compare with. Moodle assignments provide teachers with a wide range of combinable feedback, such as global or between-the-lines comments, evaluation rubrics, scoring scales or offline gradesheets³. In addition, students' submission offers ongoing assessment information that can help them make instructional decisions. For example, teachers can identify and resolve possible weaknesses or track the developing proficiency levels of the individual student in view of the final assessment.

The activity can also be gamified using a system of rewards with the aim of fostering participation and involvement. Students obtain a score for every correct exercise completed within the required time frame. The score distribution starts from 100 for the first exercise submitted and decreases by one for subsequent uploads. This decision aims to

¹ Teachers can also use H5P to create an interactive Advent Calendar. H5P is a free, content authoring plugin that can be integrated with Moodle (see <https://h5p.org/content-types/advent-calendar>, https://moodle.org/plugins/mod_hvp).

² Teachers can use the *restrict access* feature to edit the availability of any Moodle's activity or course section according to certain conditions such as dates, groups, grades or activities completion (see https://docs.moodle.org/311/en/Restrict_access).

³ See https://docs.moodle.org/311/en/Assignment_settings#Feedback_types, https://docs.moodle.org/311/en/Assignment_settings#Grade.