# PROJECT LEARN+: AN OPPORTUNITY TO DEVELOP MATHEMATICS LEARNING

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In this communication, we present the LEARN+ project and the teacher training model using the MILAGE LEARN+ platform for the teaching and learning of mathematics, which have been carried out by the Associação de Professores de Matemática (APM) from Portugal and the Federación Española de Sociedades de Profesores de Matemáticas (FESPM) from Spain, partners institutions in the Erasmus+ LEARN+ project.

*Key words: Gamification, mathematics learning, MILAGE LEARN+*.

## THE LEARN+ PROJECT

The project *Building communities of teachers producers to implement personalized learning of Mathematics supported by machine learning and block chain to assess competencies* is an Erasmus+ project, known as LEARN+, with reference number 2019-1-PT01-KA201-061246, coordinated by the University of Algarve and its aim is to create a European network of teachers who use technology in the teaching of mathematics, in particular, using a specific platform, named MILAGE LEARN+, that also emerges from a previous European proposal, which offers personalised itineraries, thus catering the diversity of students' abilities. This platform facilitates the individualisation of the learning pathway and provides feedback logs that help teachers personalise their curriculum by adapting it to the needs of the students.

The project involves partners from Portugal, Spain, Cyprus and Germany, which, at the time of the joint proposal application, were all facing a common situation of declining students' interest in learning mathematics as well as low academic achievement in mathematics. The consortium includes 10 organisations from the above countries, which complement each other concerning their experience. In addition to the University of Algarve as the coordinating institution, it involves mathematics teachers' associations from Portugal, Spain and Cyprus, as well as a German association of mathematics and science teachers. Schools from Portugal, Spain, Cyprus and Germany are also involved, covering primary and secondary school levels, as well as a German Pedagogical Centre.

For many students, mathematics is boring, abstract, uncreative, complex and very difficult to understand. However, mathematical thinking is a competence that prepares and helps young people to analyse logically and accurately situations in daily life. The LEARN+ project seeks to help students achieve success in learning mathematics through the use of technology and gamification. According to Passey et al. (2004), the integration of ICT in the teaching and learning of mathematics helps to increase students' motivation, enabling self-paced learning. Gamification involves the use of the technique and concept of gaming in diversified contexts outside games (Deterding et al., 2011) and, when applied to the mathematics teaching-learning context, can contribute to increase students' engagement. It can encourage students to study and reflect critically, according to Alves and Teixeira (2014), through interaction

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and collaboration. These authors also point out that gamification can "explore the cognitive, social, cultural and motivational qualities of students" (p. 140).

To achieve these goals, the LEARN+ project promotes mathematics learning supported by the creation of tasks, videos and gamification, with a scheme that guides both student self-assessment and peer-assessment, stimulating autonomous and active learning. The mathematical tasks posed and solved are shared through the platform by the teacher, so that he/she can also supervises them.

## THE MILAGE LEARN+ PLATFORM

The MILAGE LEARN+ platform, the main tool of the European LEARN+ project, allows the extending of the traditional learning space to virtual learning environments in order to keep students connected, thus facilitating the implementation of a blended mathematics teaching and learning model. Gamification is also incorporated, integrating tasks associated with three different levels of complexity: initial, intermediate and advanced.

Thus, the great potential of this platform is to contribute to the improvement of the teaching and learning of mathematics, including all students. In this way, student-centred learning contexts are provided. Low-achieving students, who may have difficulties in learning the content covered in class, will not only have the opportunity to access the tasks set as many times as they need, taking advantage of mobile devices, but also have access to complex problems and activities, which also aim to stimulate high achievers.

In the MILAGE LEARN+ platform, there are two components: the teacher through a specific software that is installed on the computer and allows the creation and submission of materials (tasks and videos). This component may be considered as a back office, free for teachers and schools, who wish to join the development of content in mathematics teaching and the student's APP for mobile devices, such as tablets or smartphones enabling students to access educational content in and outside the classroom.

Figure 1 shows a summary diagram of the platform, followed by an explanation of the two components of the platform. The platform is being developed progressively by the University of Algarve in order to advance the integration of machine learning and digital certification, thus facilitating personalised learning and providing teachers with information about their students' learning progress. In addition, it favours the adaptation of a work plan to the specific needs of each student, providing different itineraries according to the characteristics required. In this way, the development of 21st century skills, such as creativity, critical thinking, collaboration, communication and autonomy are promoted. As mentioned above, in order to stimulate and support the implementation of the various activities proposed, the APP interface incorporates gamification features, segmenting different levels of exercise difficulty to support students with difficulties and also motivate more advanced students in learning mathematics.

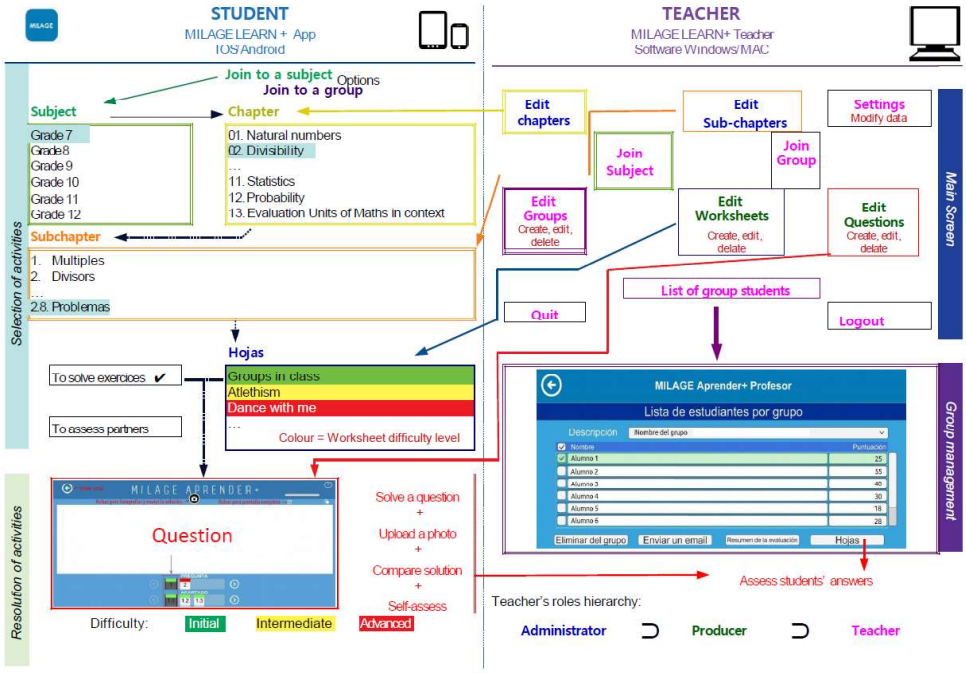
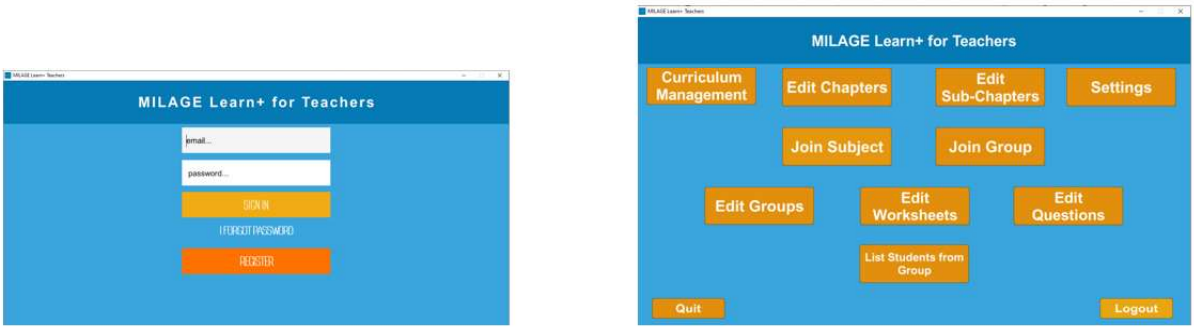



Figure 1: Overview of the MILAGE LEARN+ platform.

## The MILAGE LEARN+ tool for the teacher creating materials

First of all, the teacher's software must be downloaded to the computer, with a Windows, Mac or Linux operating system, which can be accessed from the website http://milage.io by registering there. Once the software has been downloaded and installed, it opens and the following screen appears (Figure 2A) for registration. After registering and clicking on the access, there is a screen, which allows us to enter the activities on the platform (Figure 2B).




A B

Figure 2: Main screen of the teacher's platform (A) and Screen to enter the activities on the platform (B).

On the screen (Figure 2B) where is possible to enter the tasks (worksheets) on the platform, the functions of the important tabs for the creation and submission of tasks are as follows:

- **Edit sheets:** gives access to the first level of task creation on the platform, i.e. the elaboration of mathematical tasks. First, select the level to which it is addressed (Subject), the subject to which it corresponds (Chapter) and the subsection of the chapter (Subchapter). Next, click on the circular plus icon, select the level of difficulty (Initial - green, Medium - yellow, Advanced - red) and type in a title for the worksheet.
- **Edit questions**: allow us to edit and associate questions to a worksheet already created. To create a question (problem) it is necessary to have an image file in PNG format with the questions, an explanatory video with the resolution of each of the questions and another image file for each of the solution and the scores assigned to each phase of the resolution process. Figure 3 shows an example of a problem with PNG files containing the questions and the solutions and scores for question 1 (Figure 4) and 2 (Figure 5).

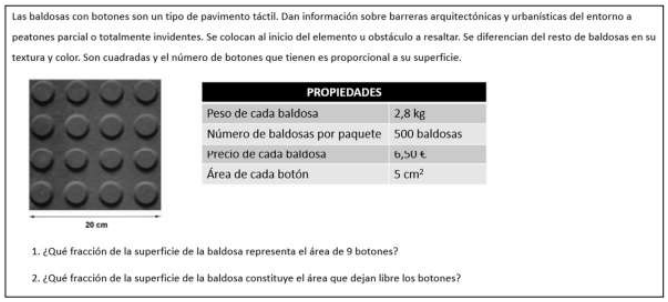



Figure 3: Example of an image of a question to be submitted on the platform.


Figure 4: Example of an image of the solution and scoring of question 1.

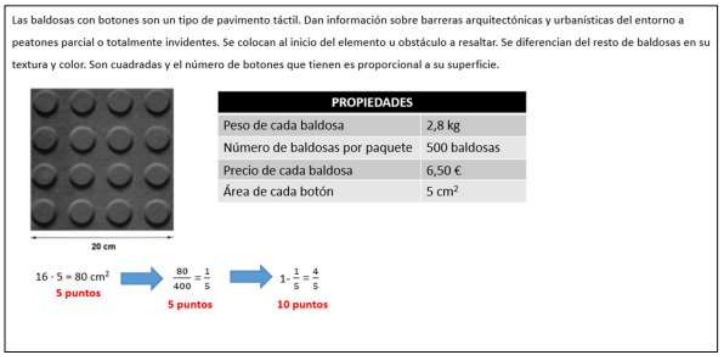



Figure 5: Example of the solution image and scoring of question 2.

For the teacher to access all of the student's work, the student has to be enrolled in a group or class. The teacher only has access to what the student does within the group/class he/she has created. He/she has access to a variety of information about the student's work (e.g.

student scores or rankings) and can download a portfolio of all the student's work, or choose the time period in which the activities were completed. It is also possible to check and validate students' self-assessment and peer-assessment and change the score if necessary.

On the platform there is a chat through which the teacher can communicate individually with the students or with the whole group.

### The MILAGE LEARN+ APP for students

The platform allows students to register (Figure 6) and access the learning content created through the teacher component.

The MILAGE LEARN+ APP, which is free and available for Android and Apple iOS systems, is a support tool for students, offering them the opportunity to independently solve worksheets with different levels of difficulty. It is also a support tool for teachers as it allows them to manage better the classroom time, in a sense where the teacher no longer has to provide the solutions to the tasks in class, as they are integrated in the application.

Once the student accesses a section of a proposed worksheet, he/she tries to solve it in his/her notebook and when he/she considers it is solved, he/she takes a photo from the mobile device, which is sent to the platform. Currently, the platform allows students to answer several types of questions such as true/false, multiple choice, short answer or text questions and to send a PDF file. After submitting their answer, the student can access the video explaining the resolution of each question and the image with the scores assigned to the different steps of the task solution process.

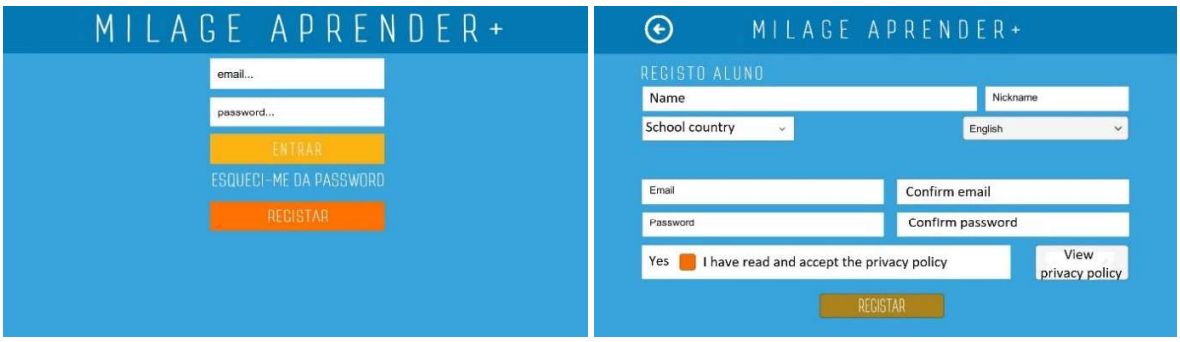



Figure 6: Main registration screen on the student platform.

In order to stimulate and support the implementation of the various activities proposed, the MILAGE LEARN+ APP interface incorporates gamification elements. Students receive points for solving the activities correctly and for assessing other students' solutions, an innovative aspect of the platform. In addition, the APP includes a self-assessment and a peer-assessment system to encourage students to work autonomously. After submitting their resolution in the APP, the student has to grade their answer and grade the answer of another student in their class, which is assigned randomly by the platform. Only after the self-assessment and peer-assessment, the student has the full score of their work.

## TEACHER TRAINING

Professional development courses for teachers, as users and as content creators for the MILAGE LEARN+ platform were integrated into the Erasmus LEARN+ project. These training courses were planned and carried out differently in Portugal and Spain, as it will be explained in the following sections.

### The case of Portugal

In Portugal, teacher training courses were carried out in two modalities: 4 and 6-hour workshops and 30-hour courses. In the workshop modality, teachers first complete a 4-hour training "Learning Mathematics with the MILAGE LEARN+ APP", where they learn how to use the platform as students (session 1 with 2 hours) and as teachers (session 2 with 2 hours) using mobile phones and computers. Only those who completed this 4-hour training session could attend the following 6-hour training "Teacher Authors: a strategy to promote mathematics learning with the MILAGE LEARN+ platform", which aims to create content for the MILAGE APP. All of the courses were done remotely, through the APM's Moodle® and Zoom® platforms.

In the 6-hour workshop (three sessions with 2 hours each), teachers go through several phases: (1) they have to create a worksheet that has up to four questions and send it to the teacher educators with the resolution and proposed score to each question, to receive feedback on the didactic and scientific aspects of the worksheet content and format of the text; (2) after receiving the feedback, they make the necessary improvements and go on to create PNG images of the questions and resolutions and a video, which they send back to the teacher educators to receive feedback on the technical aspects to be improved in the images and videos, the didactic, scientific and linguistic aspects; (3) after receiving the feedback, they have to improve their work and make the remaining videos (one explanatory video for each question). Phase (1) takes place after session 1 of the training, where it is explained how to build a worksheet for the MILAGE APP. Phases (2) and (3) take place after training session 2, where it is explained how to make an explanatory video. In session 3, teachers must have all the material prepared and ready to be uploaded to the platform (PNG images of the questions, resolutions with scores and an explanatory video for each question). Only in this session, teachers have access to producer privileges and can, in the future, create and submit content into the MILAGE LEARN+ APP autonomously.

The 30-hour courses have the same the dynamics as the 4 and 6 hours workshops. However, in the courses, teachers have to do two worksheets and not just one, to review the work of other teachers (peer-review) who are in the training, and to use the APP with students in the classroom and share the experience. All the training courses were carried out by the Associação de Professores de Matemática (APM) in Portugal integrated in the LEARN+ project and were prepared and implemented with the aim of accompanying and supporting teachers in the use and creation of content for the MILAGE APP, so each workshop or course had a duration of about 3 months. During the LEARN+ project (2019/2022), APM has supported and certified more than 1100 teachers.

### The case of Spain

In Spain, during the three years of the LEARN+ project, four courses of 30 hours each have been held. These courses have been organised by the FESPM and have been recognised by the Ministry of Education and Vocational Training. All of them have been done remotely, through the FESPM's Moodle® platform. From the second edition, the teacher educators offered streaming sessions with the participants, not so much to explain how the MILAGE LEARN+ platform works, but rather to disseminate the LEARN+ project and to share the experience of the partner school in Spain (i.e. IES Jesús de Monasterio), to encourage them to incorporate the MILAGE LEARN+ platform into its teaching practice, as well as to bring the support of the teacher educators closer to the participants. In practice, the main support was carried out through the answers to queries in the forums and the evaluation of course assignments with the required feedback.

Unlike in Portugal, in Spain, the MILAGE LEARN+ platform did not include at the beginning of the LEARN+ project tasks covering compulsory education contents, so the first two editions of the courses focused more on the APP part of the teacher as a producer of resources on the platform. In addition, the FESPM opted for a mathematics in context model for Compulsory Secondary Education. Therefore, the worksheets with tasks had to follow this schedule, which resembles, to a certain extent, the PISA model in the mathematical competence assessment units, presenting a stimulus and questions from different blocks of mathematical content. From the second edition of the course onwards, a topic was introduced in the course on classroom proposals with materials from the MILAGE LEARN+ platform, in order to promote its use. In the last edition of the course, it was considered necessary for teachers to begin by first getting to know the students' APP and then, the aspect of the platform for creating resources for teachers, with the following structure of topics covered in the training courses: 1) Carrying out activities on the MILAGE LEARN+ platform (student APP); 2) Tasks for the development of mathematical competence; 3) Resources for the creation of educational videos; 4) Creation of tasks to the MILAGE LEARN+ platform and 5) Classroom proposal with tasks from the MILAGE LEARN+ platform. Each topic was valued at 6 hours of duration, including the work on the activities to be presented in each one. In total, the FESPM training has been followed by 235 teachers in the four courses offered.

## TEACHERS' FEEDBACK

The evaluation of the teachers who have taken the training courses is very positive, in general. Spanish teachers highlight the fact of getting to the platform and its possibilities, since they appreciate as a very positive aspect that it promotes student autonomy, as well as the possibility of developing attractive activities for students. In addition, they consider that the materials created by FESPM are of high quality, promoting the development of mathematical competence. Finally, they also consider the interactivity between mobile phones, videos and mathematics to be of interest.

In Portugal, teachers emphasize the usefulness of the platform. It is easy to use in face-to-face and online context; the teacher has access to students' resolutions in an easy way; it motivates students to learn Mathematics; and self and peer assessment give students the opportunity to look back to the task and reflect on what they did and think about different resolutions.

In both countries, some teachers feel that the development of videos takes them too much time and Spanish teachers would like to have an even greater number of activities on the platform.

In the LEARN+ project, several professional development courses for teachers were held in Portugal and Spain to present the functionalities of the MILAGE LEARN+ platform, to encourage teachers to develop materials and to use the APP with their students. Teachers in Portugal and Spain took up the training courses differently, and in Portugal the uptake was higher than in Spain. However, it should be noted that the MILAGE LEARN+ platform has been running in Portugal since 2016, and Spain only joined in 2019 and that, given the pandemic situation in 2020 and 2021, its use was supported by the Portuguese Ministry of Education, which led to more teachers participating in the training.

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