

## Fostering interest in mathematics

Students in a Portuguese school practice mathematics using a Portuguese version of Khan Academy. The platform motivates them to practice and take ownership of their own learning.

### Summary

The Portuguese Ministry of Education, the Portuguese Educational Telematics Association and Altice Foundation partnered to adapt educational content of Khan Academy for Portuguese students. A teacher in Funchal has initiated the implementation of this platform in her own school. Students can master mathematics solutions in their own pace. Teachers can also do a formative assessment based on what are the areas of difficulty for each student and for the class in general and address these difficulties in the classroom or individually by meeting with each student. Although the case study relates to the topic of equations in mathematics with a class of 13-14 years-old mixed-ability students, the approach is valid for other ages and subjects.

### The policy context

Portugal has been recently undergoing a process of curriculum redesign as well as a shift towards formative assessment. This is reflected in the recent legislation and the new curriculum. Despite an increase in innovations in assessment and use of digital technologies in some schools, it is a challenge to identify, improve, evaluate and scale up these practices.

In Portugal, teachers must participate in continuous professional development (CPD) events and/or activities to progress in their career. They are expected to take part in at least 50 hours of training, half of which focus on the pedagogical dimension (for example, a teacher of English as a Foreign Language would want to choose English Language Teaching CPD events and/or activities).

During the school year 2019-2020, Portugal began the implementation of the [Maia Project \(website in Portuguese\)](#) to support formative assessment in schools (MAIA stands for *Monitorização, Acompanhamento e Investigação em Avaliação Pedagógica* which means Monitoring and Research in Pedagogical Assessment).

MAIA is a research project at the national level which aims to improve the assessment of students' learning to help them to better succeed in their learning. The project targets



mainstream and vocational courses from primary to upper secondary education and involves classroom assessment workshops where students experiment with formative assessment tools and techniques. Representatives of teacher training centres build teacher capacity to enable teachers to directly apply these tools and techniques with their own students. A core team consisting of delegates from the DGE/Ministry of Education, a higher education institution and school clusters/schools across mainland Portugal monitor the project.

In the first year of implementation of the MAIA Project, 88 teacher training workshops were conducted by teacher training centres (Centros de Formação de Associações de Escolas, CFAE), involving 1555 trainees, namely primary and secondary education teachers from 275 public schools and school clusters (called “Agrupamentos de Escolas”, AE). These workshops aimed to improve the teaching and assessment practice of teachers.

A central team and a network in the vicinity of schools involved seek to promote consistency across the workshops offered at national level in the scope of MAIA, through a variety of monitoring actions.

## Mathematics and Khan Academy

The project “[Mathematics and Khan Academy](#)” involved a partnership between the Directorate-General for Education and the Portuguese Educational Telematics Association ([EDUCOM](#)). The partnership conducted a pilot project first to try out Khan Academy resources and adapting them to specific teaching conditions in Portuguese schools. A [Portuguese version](#) of Khan Academy was created. Five school clusters (Agrupamentos de Escolas, AE) in the Portuguese Centre-West region were involved. The project ran in 2016/17 and 2017/18 and was evaluated by the Unit for Research in Education and Development (UIED), a part of the Faculty of Science and Technology, Universidade Nova de Lisboa.



## Digital tools used

[Khan Academy](#) is a set of free online tools and resources (videos, exercises, articles) for self-access online learning, often part of a flipped classroom. The original content in English have been translated into European Portuguese and adapted to the Portuguese education context by the [Altice Foundation](#) (the Portuguese telecommunications company). The content has been approved by the Portuguese Society of Mathematics, Portuguese Society of Physics and the Portuguese Society of Chemistry.

Khan Academy encourages students to learn at their own pace to fully master each topic. This empowers students to be completely autonomous in their work. Students can monitor their own progress through an easy-to-understand and motivating interface.

The platform also facilitates formative assessment. For instance, teachers can keep track of each student's progress or see the questions that were most challenging for the whole class. They can then meet with students individually or in groups to target areas of difficulty. They can also set a personalised sequence of assignments for each student to practice the topics that they have not mastered yet.

## The school context

The Dr Ângelo Augusto da Silva School is one of the many schools that took part in the project. The school is in Santa Luzia, Funchal, in the Autonomous Region of Madeira, an archipelago known for its natural beauty and tourism. The school is in a privileged residential neighbourhood. It is one of the largest schools in Funchal, with students from primary to secondary education. The schools is also a point of reference for the quality of teaching in 5th and 6th grades.

The school offers a diversified education with classes from 5th to 12th grade. It also offers CEF courses (Education and training), which are an alternative route in Portugal for students 15 years of age or above to complete compulsory education, adapted to flexible needs. The school is well equipped, with laboratories, workshops, an audio-visual lab, reprography facilities, a library, a psychology and special needs education lab, service rooms, a structured teaching unit, Music Education rooms, Visual Education/Technological Education rooms, a students' and teachers' bar, cafeteria, administrative services, sports and garden spaces.

A wide range of complementary curriculum activities is available, through projects and clubs, disseminated by the class directors and the school's website. The curriculum



enrichment activities are included in the Annual School Plan. These are a way to promote cultural and civic values, health education, physical education, artistic education and the inclusion of students in the community.

### Research - Khan Academy in schools

[Khan Academy](#) is originally aimed for use in a flipped classroom and to provide student learning data to help the teacher organise differentiated instruction according to individual student needs. However, studies show that it can be used also in the classroom with benefits and without the need for the teacher to make big changes to their teaching practice (e.g. [Light & Pierson, 2014](#)). Evidence also suggests that Khan Academy can support independent learning in students, but its use should be accompanied by the teacher's face to face interaction with the students for emotional learning (e.g [Vidergor & Ben-Amram, 2020](#)).

## Challenges

The school faces the challenge of Improving students' engagement and academic performance. In mathematics. Students have difficulties in problem-solving activities, such as mathematical equations because they seemed to have little autonomy and showed some anxiety. Teachers face the challenge of promoting responsibility, commitment and individual success and developing differentiated and flexible learning pathways. With a large percentage of recently arrived students from other countries, not speaking Portuguese, the school faced the challenge of adapting the curriculum and fostering learning at these students' own pace as well as improving their language skills.

A further challenge was creating email accounts for students compliant with data privacy requirements. The school tackled this by using school institutional emails. At the beginning of the school year, parents signed a permission form to enrol their children on the Khan Academy. The challenge of lacking access to a well-equipped classroom was overcome by swapping classrooms, with the consent of the school administration. Currently, this would not be a problem because students have tablets thanks to a [Digital Manuals Project](#), for which the internet network capacity has also been strengthened.

## Enabling factors

The activities with the Khan Academy platform were proposed by one of the teachers, Sónia Luísa Silva, who brought her personal experience using it. She presented the idea



of using the platform in the school and the school administration and colleagues were interested. The school administration supported this initiative, allocating hours for teacher Sónia to create a project with the students, and allowing her to use the computer rooms and the equipment intended for ICT classes. They also supported her with material for dissemination and streamlined interaction with the school community and support to provide incentives to participating students at the end of each school term.

Previously, students logged onto the KA Platform by using a computer or a smartphone. Nowadays, they can use tablet due to the [Digital Manuals](#) Project. Headphones are useful so that students can individually watch the videos and not disturb others working on a different task. Students are expected to have accounts at Khan Academy and be familiar with using it. Teachers can explore the platform and learn to use it on their own, without the need for specific training as the platform contains a set of support material.

Teachers have the support of the Altice Foundation who are responsible for translating the Khan Academy into European Portuguese, for adapting content and providing teacher training in Portugal.

The attitude of the school head towards digital technology is positive and there is collaboration with ICT teachers for setting up Khan Academy accounts and teaching some digital skills to students. ICT lessons support this because they provide students with opportunities to use both the platform and the email. There is home access to digital resources and the Khan Academy. Parents are also supportive of this method.

Parents are informed about the Khan Academy platform at the beginning of the school year during the first meeting with the class director, and through a flyer distributed to students. There are also two direct approaches to parents: a short explanatory lecture on the first visit to the school of the 5th year students (to learn about facilities and projects in which they could enrol); and subsequently a workshop for parents to explain how to use Khan Academy and help them register in the platform. Parents are encouraged to create a parents' account so that they can see a weekly report of their child's progress and look for other content and activities to explore together.

## Example activity

In an example activity, teacher Sónia Luísa Silva introduced the platform to her students and created the student accounts at the beginning of the school year.



There were insufficient computers in the classroom for all students to work on individually. Therefore, the class was divided into two groups. One group worked on the Khan Academy platform for 45 minutes while the other group solved notebook exercises.

At the beginning of the lesson, the teacher hands out a guide card with to-do lists for students to follow. The guide card includes topics, exercises, videos, articles already available on the Khan Academy platform, etc. The guide cards direct students to the most relevant content and help them focus on practising their problem-solving skills and not on exercises that are too easy or are not included in the curriculum. The students can do the assignments in their own pace.



*Figure 1 Students working in 2 groups: one group worked on the platform and the other group in the centre, solved math problems on their notebook.*

Students receive immediate feedback on the result of each exercise via the Khan Academy system. After completing a set of exercises, they gain points that give them the ability to unlock avatars and earn medals according to their achievements. The platform adapts to

the student's performance. It not only provides the correction to the exercises but also directs students to helpful tasks to help them improve. Furthermore, it provides answers to the exercises as well as videos with an explanation of the content.

Some students were unable to complete tasks on time, so the deadline was extended, and they could complete the tasks at home. Others asked for an extension of the deadline to have the opportunity to repeat and improve their performance.

Using the KA platform was helpful both at the beginning and at the end of the lesson. First, to elicit prior knowledge and learning gaps, and to select content topics which could be considered as prerequisites to be developed. End of the lesson activities can also be helpful to consolidate learning.

### Research - Learning analytics to scaffold learning

Learning analytics systems that underpin platforms such as the Khan Academy may provide 'meaningful pedagogical data' to explain and predict student progress toward learning objectives and also guide students toward tasks that may help them to address any learning gaps ([Thille and Zimarro, 2017](#)). Students may also develop capacities for self-assessment as they interact with online tasks ([Santos, Cook and Hernández-Leon, 2015](#)).

## Outcomes

132 students participated in the Khan Academy-based lessons in 2018/2019, 102 in 2019/2020, and 109 in 2020/2021 so far. A survey was conducted at school for the school year 2018/2019 to assess the degree of satisfaction of the stakeholders. The answer results suggested great interest and satisfaction in participating in the project involving KA. There was interest in the content topic addressed and there was progress both in terms of students' commitment, involvement and autonomy.

Parents/legal guardians were also involved. Since they knew the platform, they monitored the performance of their children (48% of the parents/legal guardians). Out of the parents who monitored their children's work, 10% also created their own accounts as parents on the platform.

Some student testimonials:

- "Now I can practice and make mistakes without fear, learning the contents"



- “I have better results in my assessments, because I can learn and redo the exercises”
- “In KA there are lessons for parents as well as the students, so I’ve learnt at home with my parents”
- “The lessons are well structured with a very systematic progression of skills. My tutor provides a clear breakdown of skills. You can try a problem several times giving you confidence to continue.”

According to survey conducted after the project, 68% of the students considered that the time dedicated was very useful. Only 16% of the students considered that their performance in mathematics had not improved. However, since then they started to like mathematics more and study through different activities. As such, these students also stated that they better understood the content and could clarify their doubts through the videos and the articles, without constantly asking for help from a teacher. They eventually came to understand some more complex content.

## Conclusion

The Khan Academy platform, with its content, use of gamification and the ease to monitor student progress, contributed to both digital and formative assessments related to the national curriculum. Students built up the confidence to speak up more in the classroom and became much more motivated, improving the relationship between teacher and student. For instance, students had an active role in formulating questions for their peers (and teacher) to answer. The students who used KA interacted in a proactive way with their peers. Students became also less afraid of making mistakes.

Teacher Sónia’s research into innovative practices led to contacts with the Altice Foundation for training and she now leads training workshops for other teachers. Other teachers use Khan Academy frequently in their classes, by assigning tasks to their students for both knowledge acquisition and autonomous work. They used it in regular classes or in student support groups and developed individual tasks to be used for formative assessment.

The school has recently extended the use of Khan Academy. Following the implementation in the Madeira region of a [Digital Manuals](#) project, enabling all 5<sup>th</sup> grade students to have online textbooks on tablet computers with support, their mathematics teachers began regularly using KA after seeing the engagement of students and their improved results. This promoted diverse learning moments and encouraged students to use Khan Academy to study.





Looking ahead, Khan Academy's digital resources for learning mathematics will continue to be used in the school because it is a powerful tool for effective feedback and formative assessment. Teacher Sónia has been invited by the Personnel Training Division in the Autonomous Region of Madeira to train teachers, and sharing her experience with Khan Academy. She is delivering workshops both in mathematics and also science, now that the Portuguese version of the platform has been developed and extended to other subjects.

