PROMOTING AUTONOMOUS WORK OF STUDENTS WITH THE MILAGE LEARN+ APP

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Abstract

In this paper, we present the *MILAGE Learn+* app, developed for smartphones and tablets in order to promote autonomous work of students in the process of learning mathematics. With this app students solve mathematics activities and get help by playing videos with problem resolutions. Autonomous learning and effective self-regulatory strategies are very important in learning; without these, students might not be able to exploit learning opportunities outside classrooms. For that, an important way of supporting learning autonomy is to promote student-centered learning approaches. Students can use mobile devices to implement a blended learning model and use the *MILAGE Learn+* app that allows the implementation of student-centered learning approaches involving students with different skills. For this purpose, the app accommodates gaming mechanics dealing with complexity and detail. It has three different levels of problems complexity: beginners, intermediate and advanced. On the other hand, each problem can have two levels of explanations/resolutions: detailed and concise. These features provide the same opportunities to all students. So, low-achieving students that may struggle to learn the materials covered in class can watch the video resolution as many times as they want until they understand the subject. But students have also access to complex maths problems that may provide additional stimulation for top performers. In this way, we provide a platform where students can work autonomously, and the app is also capable of accommodating students with different mathematic skills.

Keywords: m-learning, b-learning, mathematics, autonomous learning, gamification, mobile devices.

1 INTRODUCTION

Increasingly, cognitive scientists are finding themselves developing models, frameworks, tools and pedagogies consistent with emerging contexts and new circumstances. In these new environments, the research moves beyond simply observing and actually involves systematically engineering learning contexts in ways that allow us to improve and generate evidence-based assertions about learning. Coherent and integrated tools, content-based curriculum, and pedagogical models that help teachers systematically understand, predict and design how learning occurs in new learning scenarios are needed to cope with and benefit from the changing circumstances. As we look toward the future of education in the 21st century, the prominence of a robust STEM (Science, Technology, Engineering, and Mathematics) curriculum is unquestioned.

There is also an increasing number of students using smartphones and tablets in schools. Mobile devices gained popularity as an educational tool and there are many schools that use them frequently in educational activities to improve learning. We cannot ignore that these students are no longer the same for which the education system was designed a few decades ago. See, for example, the prospect of Heide and Stilborne [1], for whom "the technological revolution has produced a generation of students who grew up with multidimensional and interactive media sources. A generation whose expectations and world views are different from those that preceded it" (p. 27). In this context it is wise to consider the integration of digital media and mobile devices (tablets, phablets, smartphones), allowing students to set personal goals, to manage educational content and to communicate with others in the right context.

Learning mathematics is a difficult task for many students. With the availability of mobile devices that students carry with them we have a great opportunity to change this. Mobile devices give students flexibility and individualization of their learning experiences, as well as allow expanding the time spent learning outside the classroom.

In this paper, we present the *MILAGE Learn+* app (iOS and Android) for the teaching and learning of mathematics to promote autonomous work of students. Students can use this app in the classroom or outside the classroom to solve problems in a blended learning model. When students have difficulty in solving a problem they can watch the resolution. In this way, we want to promote autonomous learning and provide the same opportunities for all students, including low-achievers and top performers. For this purpose, the *MILAGE Learn+* app implements game mechanics dealing with complexity and detail. It has three different levels of problem complexity: beginners, intermediate and advanced. Each problem can have two levels of explanations/resolutions: detailed and concise.

2 A NEW PERSPECTIVE

Online interaction has become a way of life for “Generation Y” students [2], [3] wherever they are: at home, on the move, or at school. For the institutions there are good news, as for the first time in history we have a large supply of educational technologies that are chosen by students and not imposed by governments and schools: smart mobile phones (most students have one), networking software (freely available, e.g. Hangouts, WhatsApp, Skype), learning applications (widely available, e.g. Apple Store, Google Play) and open educational resources (in growing supply, e.g. MOOCs, iTunes U, Khan Academy). There are other tools available for learning organizations, such as collaborative tools (e.g., blogs, wikis, knowledge-building software), immersive environments (e.g. virtual worlds), media production and distribution tools, and many more.

Furthermore, teachers and educators have always emphasized the importance and need for "authentic learning activities", where students can work with real world problems [4]. Therefore, the development of educational activities for students that combine learning resources from the real world with those from the digital world has become an important and challenging research topic for science educators. Blended learning activities may be accomplished, for example, through the use of mobile communication and wireless technologies, allowing for experimentation, augmented reality, image collection, map sharing, and communication with other students, anytime and anywhere.

Globally, these developments lead to a re-conception of education as a mobile and flexible exchange of ideas in specific contexts. It goes beyond the traditional view of “classroom instruction”, and that of education as the “transmission of knowledge” within the constraints set by a curriculum. Instead, education is viewed as an on-going process of learning through continued exploration, participation and negotiation in various circumstances, roles and environments an individual plays a part in (e.g. school, work, leisure, family/private contexts), integrating learning and meaning making processes in formal and informal contexts. Learning in this way is in fact pervasive or ubiquitous, meaning that it is on-going 24 hours a day, seven days a week, anywhere. Pervasive learning is also a social process that connects learners to communities consisting of devices, people, and culture, so that students can construct relevant and meaningful learning experiences, authoring specific content (text, images, audio, video), in locations and at times that they find meaningful and relevant; also contributing themselves to the needs identified within these different communities. This allows learners to experience a continuous learning process, across contexts, integrating these various learning experiences by means of the affordances reachable via technology.

According to the EU Commission initiative *Opening Up Education* [5], between 50% and 80% of students in EU countries never use digital textbooks, exercise software, podcasts, simulations or learning games. Most teachers at primary and secondary level do not consider themselves as 'digitally confident' or able to teach digital skills effectively, and 70% would like more training in using ICTs. But this is also a digital challenge higher education faces: with the number of EU students rising significantly, universities need to adapt traditional teaching methods and offer a mix of face-to-face and online learning possibilities. However, even if the majority of today´s generation of learners uses digital devices, Internet applications and social media on daily basis, mostly for communication and entertainment, there is little knowledge of how to use such tools and media to make maths and science education more meaningful, effective and attractive. It is important to promote maths and science as a backdrop for learning about the real world in which we live, especially by attracting low achievers and helping them develop some of the key competences that are basic-life skills.

Moreover, teaching and learning opportunities for youth are now available in expanding learning environments [6], next to the traditional institutions (schools and universities), for example, encompassing science discovery centers, community spaces and non-profit organizations.

These students grew up in a new technological environment, with its own techno-culture, and they will live in a demanding, competitive, complex and increasingly connected world. The technological revolution has produced a generation of students who grew up with multidimensional and interactive media sources, a "Generation Y" whose expectations and perspectives are different from those that preceded it [2], [3].

Gradually, the rupture of traditional assumptions and educational models has propelled cognitive scientists into the exploration of emergent learning formats that might meet the needs of a "participative learner" by incorporating new kinds of inputs, media consumption and production practices, global resources, and accommodate the move into a more learner-centered environment. Nevertheless, at this stage, the majority of universities and schools still need to change and narrow the impact of these on-going transformations by harnessing the power of the options available in an ever-changing digital media landscape.

A very comprehensive study of the relevant literature is presented by Wong & Looi [7], including their own framework called Mobile Seamless Learning (MLS) sustained by the view that "learners need to be engaged in an enculturation process to transform their existing epistemological beliefs, attitudes, and methods of learning. Therefore, at the early stage of learners' engagement in mobile devices, teachers need to model the seamless learning process by gradually and systematically incorporating mobile learning activities into the formal curriculum" (p.5). Another study by Park [8] compares mobile learning (m-learning) with electronic learning (e-learning) and ubiquitous learning (u-learning), and describes the technological attributes and pedagogical affordances of mobile learning presented in various studies. We find relevant for maths and science learning that the mediation of mobile devices may serve as a catalyst for face-to-face interactions in the field, inside labs, or for solving problems in groups, both in schools and universities.

These scenarios point to new forms of teaching, learning and assessment that are perfectly in line with the recent report published by the UK Open University [9]. Many of the new pedagogies put forward in the report are relevant to our aims, for instance:

- *Learning through social media* - outside schools and colleges, people learn less formally.
- *Productive failure* - Productive failure is a method of teaching that gives students complex problems to solve and attempt to form their own solutions before receiving direct instruction.
- *Teachback* - As well as learning from teachers, students can learn by explaining to other students what they think they know.
- *Design thinking* - Design thinking solves problems using methods that include creative processes such as experimenting, creating and prototyping models, soliciting feedback, and redesigning.
- *Learning from the crowd* - Appealing to the crowd gives access to valuable sources of knowledge and opinion.

3 ASSUMPTIONS AROUND AUTONOMOUS WORK

Mobile pedagogy is founded on the belief that mobile devices can support self-directed learning and learner autonomy. Learning maths through mobile devices is not simply the transfer of current teaching and learning materials and the practice to mobile device, but it is a complete reconceptualization of these. For that, this mobile application makes available not only content but also opportunities to promote communication and collaboration among users. Subsequently, assumptions around the concept of autonomous work by the learner are put forward.

There is much discussion around the expression "autonomous learner" but there is some agreement, broadly speaking, that autonomous learners understand the purpose of their learning program, explicitly accept responsibility for their learning, share the same learning goals, take initiatives in planning and executing learning activities, and regularly review their learning and evaluate its effectiveness [10].

According to Lee and Hannafin [11], to establish autonomy in the student-centered learning framework, it is important to ensure that students own their learning processes. Students mediate learning processes when they determine and accomplish learning goals; Teachers, in effect, should support student autonomy because it promotes students' engagement, concentration, better time management, self-regulation, and higher performance [12], [13] .

Thus, learner autonomy does not mean independence. It is a holistic view of the learner that requires them to engage with the cognitive, metacognitive, affective and social dimensions of learning. In other words, there is a consensus that the practice of learner autonomy requires insight, a positive attitude, a capacity for reflection, and a readiness to be proactive in self-management and in interaction with others.

However, autonomous learning and effective self-regulatory strategies are very important in learning; without these, students might not be able to exploit learning opportunities outside classrooms. For that, an important way of supporting learning autonomy is promoting student-centered learning approaches to encourage and engage learners in decision-making, and in the processes of learning during and between lessons.

Lee and Hannafin [11] designed a framework for enhancing engagement in student-centered learning and point out that:

> *Students maintain personal responsibility for learning as they utilize external resources. Autonomy supports two roles in student-centered learning: sovereignty and responsibility. In terms of sovereignty, students assume the power and control to determine learning goals, decisions, and actions required to achieve those goals. When encouraged to make decisions, students perceive it as taking control of their learning and develop personal ownership. For responsibility, students become accountable for the consequences of their goals, decisions, and actions. They assume responsibility for managing their learning processes and project completion. (pp: 715)*

Deci and Ryan [14] agree that students perceive autonomy in their learning when teachers support their interests, preferences, values, and psychological needs. Supportive learning environments provide more confidence on how assignments are designed; provide opportunities to make individually relevant and interesting choices so students express their own needs and integrate them into the classroom activities; allow time to work on a problem in individual ways. [11]

Therefore, some studies investigated the influence of motivational factors and self-regulatory strategies on autonomous learning behavior [15]. According to Dörnyei [16] motivation could explains why people select a particular activity, how long they are willing to persist in it, and what effort they invest in it. Successful learning and performance go hand in hand due to internal or/and external motivation.

Another aspect to consider is called "learning on demand". It is becoming a type of lifestyle in modern society [17]. Thus, learners should not be considered as passive information consumers rather than active co-producers of content. Smartphone are suitable platforms that perform many of the functions of a computer, for example, they have a touchscreen interface, available tools to record, take pictures, make digital editing, have internet access, or share content easily, among others. Therefore, students may explore learning opportunities outside classrooms and experience autonomous learning in mobile contexts.

To sum up, there are several assumptions to consider in learning autonomy: self-regulatory strategies to learn, learning effort, autonomous learning behavior, motivational orientation, counseling, peer-to-peer collaboration. For that, encouraging learner autonomy and independent learning are crucial factors to be successful in learning.

The next section describes the *MILAGE Learn*+ app for iOS and Android that students can use to study mathematics. The rationale is that mobile learning with this tool may offer opportunities for students to become autonomous, self-motivated, and promote informal learning or/and be part of the school experience.

4 THE MILAGE LEARN + APP

When teachers use the application *MILAGE Learn+ Teachers* they enable students to access worksheets of problems with instructions, for self and peer assessment, and videos with the resolution of problems [18]. Each worksheet includes a set of questions of a selected sub-chapter, chapter and subject (year grade) of the mathematics curriculum. Teachers can upload multiple choice, true or false, or open questions for students with any order; no limitation exists about this.

Students use the *MILAGE Learn+* app in a smartphone or a tablet to solve the worksheets of problems that were made available by the mathematics teacher. After the login screen, the student has to choose the worksheet of problems that he wants to solve or evaluate one of his peers (Figure 1).

In this way, the student can study by solving problems or by revisiting the subject when he is evaluating the work of another student. Inclusion of peer evaluation contributes to the promotion of formative learning, fosters learners' independence and responsibility for the learning process.

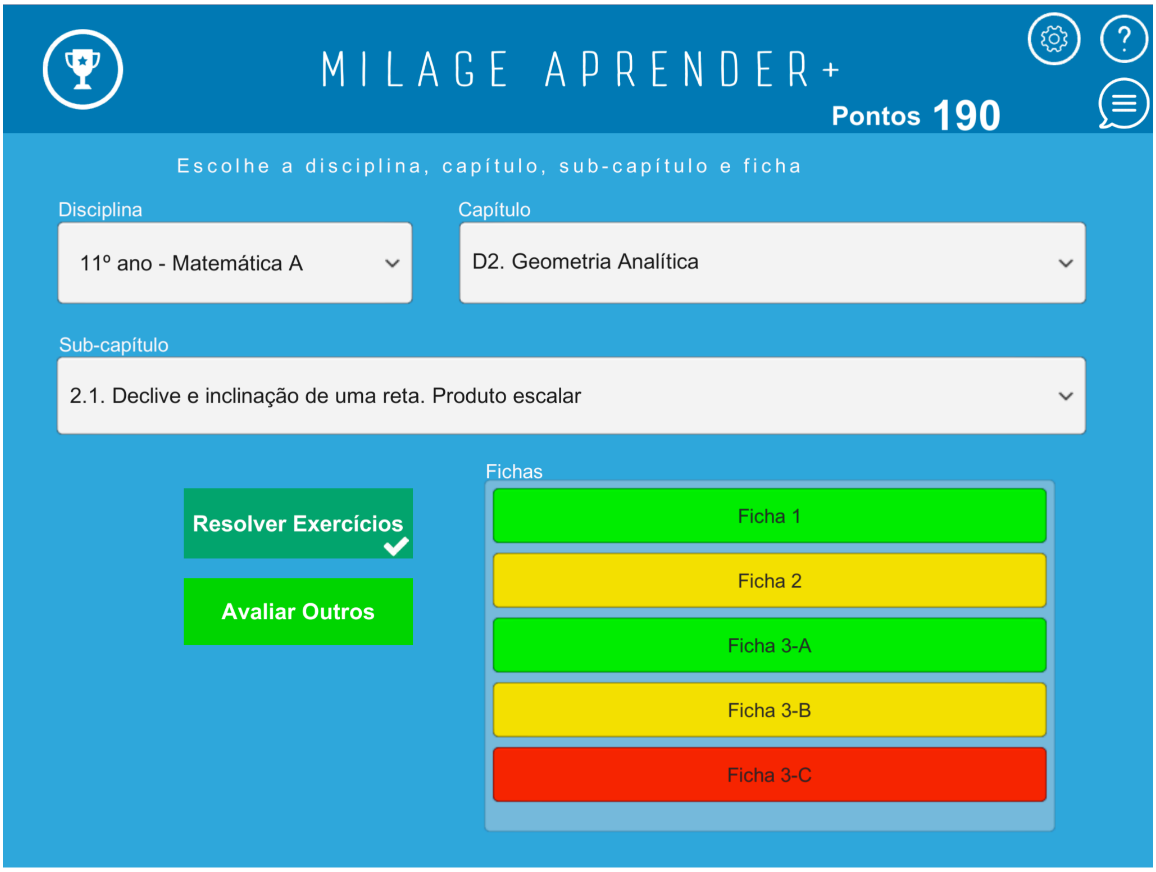

Figure 1. The student chooses the subject to study. He may solve worksheets of problems or he may assess a peer.

Each worksheet of problems relates to the year, chapter and theme of the mathematics curriculum. At present time there is mathematics content for Portuguese, Spanish, Norwegian and Turkish programs because these are the partner countries of the MILAGE project. After selecting the worksheet of problems, the student starts solving questions (Figure 2). At this point it is shown one question at a time. If the question is multiple choice, the student selects the right answer in a very straightforward way and the app can automatically identify if the answer if correct or wrong.

If the question is an open question then the student makes the resolution with pen and paper and takes a picture, using the mobile device, uploading it to the server (Figure 3). Next, the student receives the instructions for self-evaluation. When the student finds it difficult to solve the problem, he can access the video with the resolution.

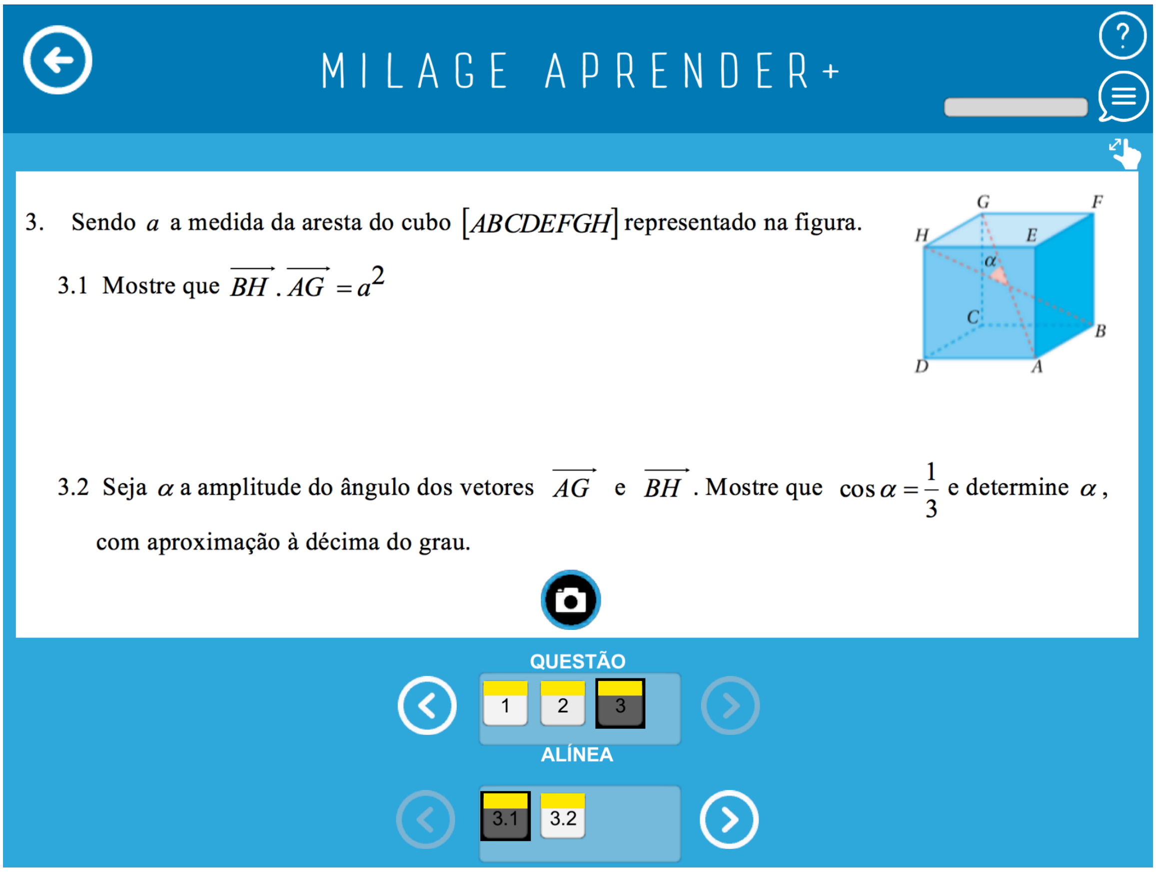

Figure 2. The student solves problems in the worksheet.

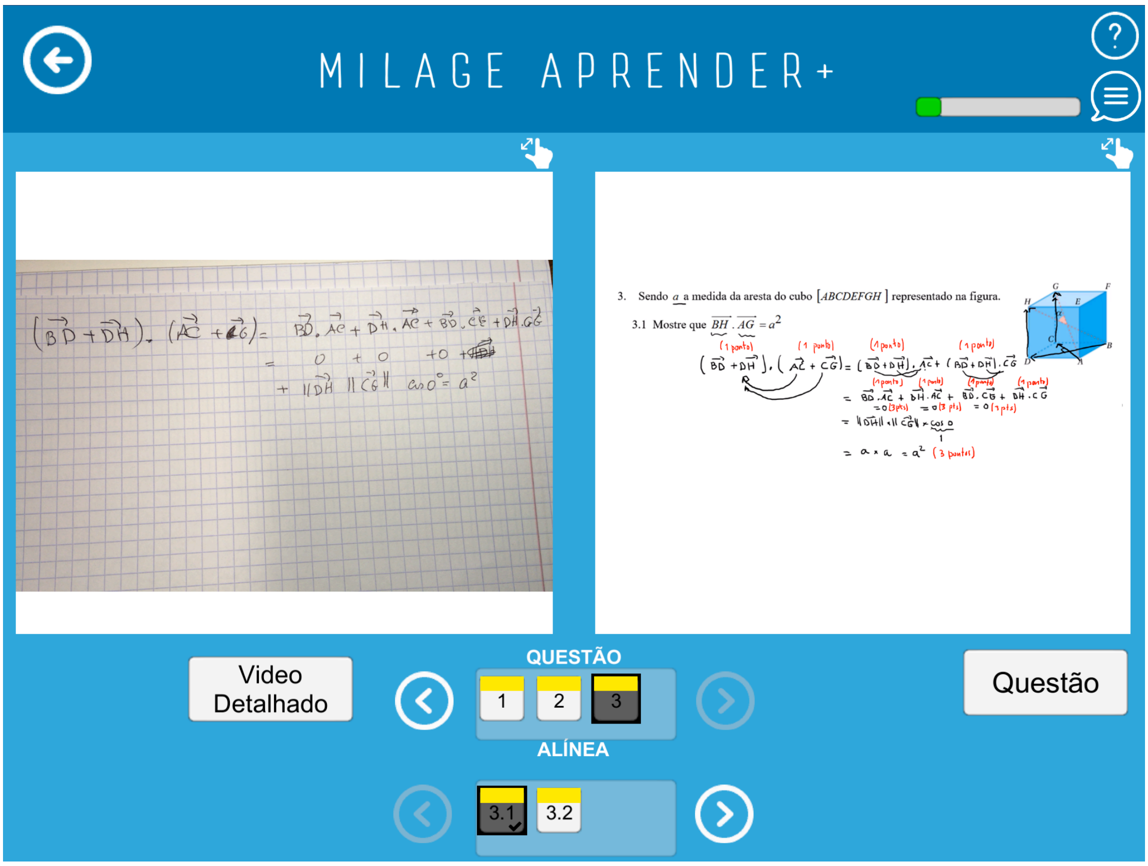

Figure 3. The student has immediate feedback on his achievement.

5 CONCLUSION

In this paper we examined the implications of relevant theory and research to clarify the guidelines that support students' engagement and autonomous learning through mobile devices. For that, we considered that students should achieve their own learning goals, develop self-regulatory strategies and use the potential of mobile learning beyond the classroom.

In this context we presented the *MILAGE Learn+* app that gives students access to mathematics problems and videos with problem resolutions, enabling the expansion of the classroom into a virtual space where students can study autonomously. This app also introduces a gamification process that is based on game mechanics with different levels of difficulty in order to integrate both low achiever and top performer students in the same platform.

The preliminary tests within the MILAGE project have shown this to be a promising effort in learning mathematics, and we argue that perhaps some other education processes could be improved by adding the "gamification factor" to involve students in a way that is more physical (using mobile learning), thus learning becomes more intense and memorable.

6 ACKNOWLEDGEMENT

This research has been supported by an Erasmus+ Project, funded by the European Union - the "MILAGE: Interactive Mathematics by implementing a Blended-Learning model with Augmented Reality and Game Books" (Nº 2015-1-PT01-KA201-012921),

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