Using the ThingLink Computer tool to Create a Meaningful Environmental Learning Scenario

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Abstract

The primary objective of a smart city is to optimize city functions and promote economic growth, while also improving the quality of life for citizens by using smart technologies and data analysis. Within this context, this article presents a learning scenario which is built with the "ThingLink" computer tool. This learning scenario was applied in an educational context of teaching Spanish as a foreign language. Active methodologies have been used so that students, at their own pace, with the help of the teacher, could not just develop subject-specific skills, but also transversal skills, in a perspective of education for an informed citizenship, interventional and responsible. A significant global improvement of 14.39 % in students' performance was verified, the number of grades below 50% was greater in the test applied before the completion of the learning activities, and the number of maximum grades was lower in the test applied before the completion of the learning activities.

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1. Introduction

It is well known that the ultimate goal of a smart city is to optimize city functions and promote economic growth, while also improving the quality of life for citizens by using smart technologies and data analysis [1–3]. Emphasis should be placed on how the technology is used rather than on how much technology is available. Additionally, the smartness of a city is measured through a set of characteristics, which includes environmental initiatives.

On the other hand, environmental education should allow individuals to explore environmental issues, participate in problem solving, and take action to improve the environment. As a consequence of this education, people should develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions.

In the current School, according to the humanist paradigm of post-modernity, the student, "digital native" [4], must be the dynamic agent in the teaching/learning process, being the builder of his/her own knowledge, by being involved in knowing how to do in action, learning to know, researching, doing, solving problems, exercising critical and creative thinking, living together, being, questioning, evolving, and being able to develop various skills. That is, it is up to the school to guide its action, meeting the four pillars of education defended by Delors [5], namely: "learning to know", "learning to do", "learning to live together" and "learning to be".

At least in Portugal, these assumptions are well expressed in Opinion No. 4/2017 [6], of 30th May, of the Portuguese National Council of Education: "The skills and knowledge considered fundamental for the 21st century in OECD member countries, according to the work '21st Century skills and competences for new millennium learners in OECD countries', are varied and include, among others, creativity/innovation, critical thinking, problem solving, decision making, communication, collaboration, literacy in the use and access to information, investigation and research, media literacy,

digital citizenship, Information and Communication Technologies (ICT) operations and concepts, flexibility and adaptability, initiative and self-orientation, productivity, and leadership and responsibility" (p. 10744).

Today, schools are facing several challenges. In fact, in two centuries, schools have changed little, despite the fact that students, society and the labour market have undergone changes, as it continues, in most cases, very much rooted to the industrial paradigm where the teacher, in the traditional classroom, tries to teach the same to all students, as if it were a "factory", as they follow "the school day and week according to the logic of the assembly chain, passing from hand to hand of teaching until supposedly the finished product came out" [7, p. 73]. However, schools cannot continue to try to train 21st century students with teachers who use 19th century methodologies, much less be seen as "factories for reproducing social inequalities" [8, p. 6], but rather as "shipyards of humanity" (idem), since students have changed, as has society and the labor market, with only a few school institutions missing to monitor and correspond to these changes. This idea is corroborated by Formosinho, Machado and Mesquita [9], who argue that, "In the 21st century, the Portuguese educational system maintains the school format it inherited from the 19th century and it is difficult for it to disassociate from it at the level of school organization and the curriculum (...)" (p. 62).

Given the Information and Knowledge Society and rapid technological advances, it is a *conditio sine qua non* that the teacher follows the change, investing in a new educational paradigm, based on humanist and constructivist theories, in which students, through active methodologies and resorting to the effective and contextualized integration of technologies, they are guided to autonomously and critically build their own knowledge, ceasing to be simply consumers of information, as was the case in the Industrial Age model.

In this perspective, the teacher, as a critical and creative agent of change, must invest in training and professional development, given that the teaching profession is always in constant updating of knowledge and skills so that he/she can correspond to the various challenges of the 21st Century School.

In the pedagogical experience presented here, we chose to create a learning scenario, using the "ThingLink" computer application, in which students are invited to perform seven challenges, using the LearningApps, Google Forms, Quizizz, Kahoot!, Canva and Lino tools, with the aim of promoting awareness for the defense of the environment, broadening the lexicon on the subject of the environment, knowledge of the main natural disasters and the development of multi-literacy skills. It was developed aimed at the following objectives: to raise awareness of the protection and preservation of the environment; to promote values and attitudes within the scope of environmental education; to expand vocabulary related to the environmental theme; to know the main environmental problems; to know the main natural disasters; to understand an audiovisual message; to develop the ability to research, select and process information, written expression, autonomy, critical thinking, creativity, collaborative work and digital competence. According to the achieved results, we found that the use of technologies in the classroom can make a difference, contributing to learning to become more motivating and fruitful, increasing the level of motivation and interest in the Foreign Language (Spanish), as well as to an improvement in educational success.

The remaining of this paper is organized as follows. Section 2 is dedicated to present the importance of the use of digital tools in the learning process. The "ThingLink" as a teaching and learning tool is presented in Section 3. Section 4 is used to present the pedagogical experience and the results achieved. The paper concludes with the presentation of the main conclusions in Section 5.

2. The importance of digital tools in learning

In Portugal, since the 80s of the 20th centuries, there have been several political intervention initiatives for digital training, both at the level of teachers and schools, in order to develop a school with digital resources and teachers trained for teaching, using ICT. Along this path, several initiatives stand out, such as the Minerva Project, Nónio Século XXI, Ciência Viva Program, Internet at Schools Program, European School Net, SeguraNet, EDUTIC, CRIE mission team, Educational Resources and Technologies team (RTE), the Technological Plan for Education (PTE) and, more recently, the Action Plan for the Digital Transition.

These initiatives have been contributing to a growing appreciation of digital skills in the school context, to a digital equipping of schools and to raising teachers' awareness of the use of digital technologies in the classroom.

Despite all the efforts and investments mentioned above, it was found, with the pandemic resulting from COVID-19, that the use of digital platforms and tools reached a significant peak during distance learning. In this sense, the school, known as it used to be, had to adapt, forcibly, to new times.

Educational technologies have always been arousing great interest in terms of their potential for motivating, engaging students and improving learning. In this perspective, we intend to show the possibilities and positive contributions that digital tools make possible in the teaching/learning process, namely in terms of the assistance they can give to the strategies and methodologies used, in order to assess their relevance and impact.

A great number of studies indicate that the use of technological tools, in an educational context, is an asset

for teachers and students who use them, in contrast to those who still resist them.

Freeman et al. [10] sate that "Although theories of learning that emphasize the need for students to construct their own understanding have challenged the theoretical underpinnings of the traditional, instructor-focused, "teaching by telling" approach, to date there has been no quantitative analysis of how constructivist versus exposition-centred methods impact student performance (…)" (p. 1).

According to Freire [11], one should not be a naive appreciator of technology. Although we, a priori, know that technology brings a huge potential of stimuli and challenges to the curiosity of children and adolescents, there is an imperative and vast path that must be taken to transform it into a tool for social inclusion, as also reflected in the Portuguese Decree-Law No. 54/2018, of 6th July, and the development of citizenship in a well-structured and defined political-pedagogical project.

It is also worth highlighting some recent Portuguese legislation on the importance of using technologies, in order to shorten distances in terms of learning, motivation and the acquisition of skills required of the 21st century student, namely:

- Dispatch No. 6478/2017, of 26th July [12], on the Profile of Students Leaving Mandatory Schooling (PASEO), which contains skills required of students directly related to the importance of knowing how to use digital resources proficiently, in almost all domains. In this sense, digital resources have their space and role very well defined with regard to the aid tool for the construction of knowledge;

- Decree-Law No. 54/2018, of 6th July [13], referring to inclusive education, in which digital technological resources are presented as tools to shorten distances, facilitators and promoters of inclusion;

- Decree-Law No. 55/2018, of 6th July [14], on curricular autonomy and flexibility, which establishes the curriculum for basic and secondary education, the guiding principles for its conception, operation and assessment of learning, in order to ensure that all students acquire knowledge and develop skills and attitudes that contribute to achieving the competences provided for in PASEO.

In fact, the available digital technologies allow us to capture, store, organize, search, retrieve and transmit the relevant information with extreme efficiency. It should be noted that any place can contribute as an educational space, both for its characteristics of individual formation and a place of connection with the school world.

Kenski [15] advocates that ICT provide a new type of interaction between the teacher and the students, enabling the creation of new ways of integrating the teacher with the school organization and with other teachers. The use of different tools thus becomes an ally of the teaching/learning process. As stated by Giordan [16] we must take advantage of this opportunity to access different sources of information and knowledge brought by communication mediated by computer networks.

The incorporation of ICT in education has consequences, not only for teaching practice, but also for the learning processes. However, the simple incorporation or use of ICT by itself does not necessarily generate processes of innovation and improvement in teaching and learning. In fact, there are certain specific uses of ICT that seem to have the ability to trigger these processes.

In the teaching/learning process, by using new technologies, the teacher, as a mediator or advisor, begins to consider the profile of the students, their prior knowledge, learning preferences, cognitive styles, contents and teaching/learning methods.

The Internet is not just a communication and information search tool, as it constitutes a space for learning and collaboration for the construction of knowledge.

In this follow-up of ideas, and according to [17], technology applied to education can bring numerous advantages to the student, as long as it is well integrated and contextualized in the curriculum. For this to happen, the teacher has the important role of exploring the learning possibilities that digital tools bring to the student, using them in a collaborative and interactive way, and as tools in the construction of knowledge. Basically, ICTs are characterized by a set of technological resources that, integrated with each other, make it possible to share, through multidimensional communication, all the knowledge produced.

The incorporation of ICT in schools, as long as the teacher has adequate training, can bring benefits to the student and should induce research and reflection on practice, as well as pedagogical innovation.

In terms of the use of technologies in education, several authors point out that the integration of ICT in teaching should be understood as a dynamic process and continuous reflection in which both technologies and pedagogical practices can be analysed and transformed, accordingly with the contexts and individuals involved [18]. In this assumption, digital tools can be used as important tools or technological resources that, integrated with each other, facilitate the teaching/learning process, arouse the interest of the student, enabling the contextualization of the topic dealt with, the manipulation of parameters and observation of the results, in addition to allowing interactivity and interdisciplinary.

In summary, digital tools, by a short definition, are "any type of software or hardware that can be used for education" [19, 20]. Moreover, authors in [21] state that sustainable development of technologies give life for idea of smart cities which consist of all the visions towards modern world.

With regard to learning support platforms, these have proven to be an asset, as they facilitate the availability of resources in different formats, such as text, video, audio, links to websites, information for students, teacher-student interaction through communication and research tools, tools to support collaborative learning, recording of activities carried out by students, learning paths that combine various digital tools created by teachers and/or students, among others. Through the digital resources available on these platforms, the student finds him/herself in a central place in relation to learning, because he/she

decides when and where to access work, which resources to use and with whom he/she wants to work. These digital platforms, combined with the web of digital hyperlinks to a multitude of tools and technological resources, started to be used in a hybrid teaching regime, in support of non-face-to-face sessions, and also in support of the in-person regime, at all levels of teaching and subject areas. The "ThingLink" computer tool is an excellent example of such platforms.

Concerning the Portuguese case, the first steps towards the use of the computer and the internet as resources for teaching and learning were done in the late 90's of the XX century. For example, in [22] and [23] the authors present their experience "in furthering the educative use of Information Technology and the internet in the primary schools of northeast Portugal". This was the first experience of its kind in Portugal, involving 1,137 schools, more than 1,700 teachers, and roughly 13,000 students. They concluded that "the transfer of the training process from the university campus to the schools and communities themselves allowed for a very high degree of teacher participation" and that "the efforts to put theory into practice in the classrooms were rewarded by a quicker rate of acceptance of IT in the classroom". After these first steps much work is being done and experiments were conducted reaching from studies involving both students from the regular curriculum ("normal" students) [24] and students with disabilities [25]. Researchers in [26] present the foundation of a framework for Interactive Adaptive Learning Systems that gives extensive attention at each stage of the design process to the end-user: learners.

3. ThingLink as a teaching-learning tool

To access the "ThingLink" tool it is necessary to register or login with a Google, Microsoft, or social media account, such as Facebook or Twitter.

This tool is available in an educational version for students and teachers, being only free in Edu Basic mode, as Edu Premium is paid.

It is a tool with a very intuitive interface that allow us to assign labels (tags) of interactivity, in a 2D or 360º image, or even in a video, allowing the integration of other images and videos, titles, text, audio, quizzes, questionnaires and links to diversified content. The user can also choose the icon and its color, as well as the place where it will be placed, in the image or video selected as "background".

It is a tool with a lot of educational potential to address and consolidate varied themes and content, access content and activities anytime and anywhere (provided there is an Internet connection), promote a more stimulating, active and interactive learning that "not only helps to focus students' attention but also helps them to learn" [27, p. 10]. It also allows an individual or group learning path, according to the pace of each student, and the development of various skills, which can be used in any subject or interdisciplinary project to create a learning scenario or a guided virtual visit, under a face-to-face, distance or hybrid learning.

The sharing of the built product is done through a link, incorporation on websites, email or social networks. "ThingLink" is available for iOS and Android, but it is also capable of producing content automatically available for web applications.

4. Presentation of the pedagogical experience and the results obtained

As stated in the introduction section, the learning scenario was created within the thematic unit on environment, in the Spanish as a foreign language course, aimed at the following objectives: to raise awareness of the protection and preservation of the environment; to promote values and attitudes within the scope of environmental education; to expand vocabulary related to the environmental theme; to know the main environmental problems; to know the main natural disasters; to understand an audiovisual message; to develop the ability to research, select and process information, written expression, autonomy, critical thinking, creativity, collaborative work and digital competence. Figure 1 shows a general overview of the learning scenario [28].

The target audience was 21 students, with an average age of 14 years old, from a 9th grade class at a secondary school in the district of Vila Real, Portugal. These 21 students were all from the same class, and all the students of the class were included in this experience. In fact, we have access to only one 9th grade class, and because the number of students participating in this study is relatively small, we have conducted a case study.

In the construction of the learning scenario, in addition to "ThingLink", the tools *LearningApps*, *Google Forms*, *Quizizz*, *Kahoot!*, *Canva*, *Lino* and *Mentimeter* were used, having chosen, as support, a 360º image of a representative landscape of the Douro Demarcated Region.

Figure 1. General overview of the learning scenario. The learning scenario was created using a 360º photograph.

The students, the main actors in the entire teaching/learning process, were invited to embark on a stunning journey from the bank of the Douro River to the top of the mountain, using their smartphones. Along the way, they carried out, working in pairs, seven challenges, namely:

- Challenge 1 – audiovisual comprehension of the video "La Hora del Planeta 2021: pongamos a la Tierra en el centro de todo" (Earth Hour 2021: let's put the Earth at the center of everything) of the Non-Governmental Organization World Wildlife Fund (WWF), through a questionnaire made on *Google Forms*;
- Challenge 2 – solving questions about environmental problems, with the *LearningApps* application;
- Challenge 3 – association of the name of the natural disasters with the respective image, using the *LearningApps* application;
- Challenge 4 – solving of a questionnaire, using *Google Forms*, to expand the lexicon on the theme of the environment;
- Challenge 5 – participation in the game created with the *Quizizz* tool;
- Challenge 6 – participation in the game created with the *Kahoot!* tool;
- Challenge 7 – research, selection and processing of information for the creation of a poster with the *Canva* tool, containing examples of beneficial and harmful behaviors for the environment, and subsequent publication on the Lino digital wall.

A test was applied, before and after the conclusion of the seven challenges/learning activities, whose global results are shown in Figures 2 and 3. According to these plots, we can see that there is a significant improvement in students' performance, which goes from 66.71% to 81.1%, that is, there is an increase of 14.39%.

Figure 2. Distribution of the total scores of the test applied before the learning activities.

Figure 3. Distribution of the total scores of the test applied after the learning activities.

Regarding the lowest classification in the test applied before the learning activities, it is verified that it is 22% while in the test applied after the completion of the learning activities it is 49%.

The number of grades below 50% in the test applied before the completion of the learning activities is six and, in the test, applied after the completion of the learning activities it is only one. As for the maximum grade (100%), in the test applied before the completion of the learning activities, only one student managed to obtain the maximum value, and in the test applied after the completion of the learning activities, there were five students.

Table 1 shows the performance of the class in each question of the tests, both before and after the completion of the seven learning challenges/activities.

Table 1. Global results of the tests, both before and after the completion of the seven learning challenges/activities.

Question	Before	After
1	4 out of 10 items with a correct response rate of less than 50%	2 out of 10 items with a correct response rate of less than 50%
2	16 correct answers	19 correct answers
3. a	61.9%	75.0%
3. b	76.2%	81.0%
3. c	90.5%	90.5%
3. d	90,5%	95.2%
3. e	61.9%	66.7%
3. f	57.1%	75.0%

4	18 correct answers	20 correct answers
5	15 correct answers	16 correct answers
6	12 correct answers	18 correct answers

Given the obtained results in each question of the tests (before and after the completion of the entire set of activities), we can conclude that there was a positive evolution in the students' learning.

At the end of the learning scenario, the students also filled out a self-assessment questionnaire, created in Google Forms, in which 57.1% of the students rated the importance of the topic and the content covered as "interesting", and 42.9% rated it as "very interesting". No student reported "not interesting" or "not at all interesting".

Regarding the degree of satisfaction with the activities performed, 52.4% revealed being satisfied, and 47.6% very satisfied. Nobody mentioned that they were little or not satisfied. Concerning overall performance of students in carrying out the activities, it was considered good.

As for the assessment of the level of performance in the competence areas of the Portuguese "Profile of Students at Compulsory Schooling", mobilized to meet the challenges, applying a five-level Likert scale, it stands out level 4 in languages and texts, information and communication, critical and creative thinking, and interpersonal relationships. Level 3 was assigned only in scientific and technological knowledge, which reinforces the idea that students, despite being born in a digital context, have a superficial knowledge of technologies, when used for learning and knowledge construction.

Level 4 is also highlighted in terms of motivation to carry out the challenges, participation, commitment and duration of the learning scenario.

According to the opinion expressed by the students, interactive games made with *Kahoot!* and *Quizizz*, as well as the questionnaire done on *Google Forms*, were the most appreciated challenges. The construction of a digital poster with the *Canva* tool was the one that aroused the least interest, since it implied more complex multi-literacy skills required of the 21st century citizen. In other words, these data support the thesis that it is urgent to teach students to make the most of digital applications, enabling them in the new digital literacies.

Also, according to the five-level Likert scale, 19% of students globally attributed level 3 to the learning scenario, 57.1% to level 4 and 23.8% to level 5.

Finally, using the *Mentimeter* tool, it was found that most students have the opinion that they performed the activities very easily, as can be seen in Figure 4.

As an example, we present some very positive testimonies from students about the pedagogical experience developed: "The Kahoot! and Quizizz tools helped in learning." (A2); "The learning scenario was very creative and a good way to learn and learn more about the environment." (A3); "The classes are being

fun." (A5); "I, in general, enjoyed all the challenges." (A7); "I found the learning scenario very interesting and interactive." (A8); "I liked the activity; it was productive and very interesting." (A16); "I think that, with this activity, we learned a lot about the environment and natural disasters." (A18); "I really liked it, because it's a very important topic, which we can't forget about." (A19).

Figure 4. Students' opinion on the developed activities (in Spanish, the language used to develop the learning scenario).

5. Conclusions

Improving the quality of life for citizens by using smart technologies and data analysis is the ultimate goal of a smart city. The smartness of a city is measured through a set of characteristics, which includes environmental initiatives.

People's education should develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions. Currently, students live immersed in technologies, which are a natural part of their *modus vivendi*, of which the mobile phone stands out, as they live connected 24 hours a day and can no longer imagine their life without this equipment.

In this sense, this mobile device, rather than continuing to be banned in many educational establishments, should be integrated into everyday classroom practices as a powerful tool for learning and building knowledge, whether in Spanish as a foreign language classes or in classes from other subjects, in order to break with teaching that is still too "transmissive" and include emerging strategies, such as task-based learning, collaborative learning, game-based learning, and "gamification" of which the learning scenario presented here is an example.

In fact, implementing the Bring Your Own Device (BYOD) concept, making the students' mobile devices pedagogically profitable, is a way of giving them a more active role in the teaching/learning process and making them content producers.

In view of the results obtained and the observations made, we believe that technologies, combined with pedagogy,

enhance more stimulating, enriching and lasting learning, thus contributing to increasing motivation for a foreign language, improving the quality of the learning experience and, concomitantly, the increase in educational success. As we have seen above, there was a significant improvement in students' performance, which had grown from 66.71% to 81.1%, corresponding to an improvement of 14.39 %. We have also observed an improvement regarding the lowest classification achieved by the students, which was 22% in the test applied before the learning activities, and 49% in the test applied after the completion of the learning activities. The number of grades below 50% in the test applied before the completion of the learning activities was 6 and, in the test, applied after the completion of the learning activities was only 1. As for the maximum grade (100%), in the test applied before the completion of the learning activities, only 1 student managed to obtain the maximum value, and in the test applied after the completion of the learning activities, there were 5 students.

It is therefore urgent to invest in the promotion of active learning activities in order not only to correspond to the challenges of the new educational paradigm, but also to the interests, expectations and needs of each and every student, in a school that it is intended to be inclusive, open to creativity, experimentation and innovation, a motor for the development of skills registered in the Profile of Students on Leaving Mandatory Schooling and a lever for everyone's success.

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