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Gamification and transmedia for scientific promotion and for encouraging scientific careers in adolescents

Gamificación transmedia para la divulgación científica y el fomento de vocaciones procientíficas en adolescentes

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ABSTRACT

The current growth in gamification-based applications, and especially in what is known as Digital Game-based Learning (DGBL), is providing new opportunities with considerable educational potential. In the present study, we report on the results of the progress of a project for developing a setting for a gamified website carried out ad hoc, complemented by transmedia resources and aimed at scientific promotion and the promotion of technological and scientific careers (S&T) in adolescents, who are at a stage in life when career preferences are established. At present, the decrease in S&T careers is one of the greatest problems for the society of technological development that we live in, where the number of professionals working in key areas for economic development and progress is declining. After completing a pre- and post- project participation survey, the results suggest a high level of efficiency achieved by projects of this type due to their online experimentation design, the knowledge of real cases of research activity, and the communication of positive scientific values and attitudes appropriate for the target population. The participants significantly increased their interest in the subject area, scientific professions, and research activity and their social benefits demonstrating the acquisition of positive attitudes towards scientific knowledge and skills.

RESUMEN

En la actualidad la proliferación de aplicaciones basadas en gamificación y especialmente en el denominado Aprendizaje Digital Basado en Juegos (Digital Game-Based Learning, DGBL) abre un panorama de elevado potencial educativo. En el presente trabajo se muestran los resultados del desarrollo de un proyecto con el funcionamiento de un entorno web gamificado y realizado ad hoc, complementado con recursos transmedia y dirigido a la divulgación científica y al fomento de las vocaciones científico-tecnológicas (CyT) en adolescentes, siendo precisamente en este rango de edad donde se configura la preferencia vocacional. El descenso de vocaciones CyT supone uno de los mayores problemas actuales para la sociedad de desarrollo tecnológico en la que nos encontramos, con un descenso generalizado de profesionales en áreas claves para el desarrollo económico y de progreso. Tras la realización de una encuesta previa a la participación en el proyecto y la misma encuesta tras la realización del mismo, los resultados obtenidos indican la elevada eficacia de proyectos de este tipo, diseñados en base a la experimentación online, el conocimiento de situaciones reales de la actividad investigadora y la comunicación de valores y actitudes procientíficas de forma afín a la población objetivo. Los participantes aumentan significativamente su interés por la profesión científica, la actividad investigadora y su beneficio social manifestando la adquisición de conocimientos y destrezas procientíficas y poniendo de relieve su interés por la temática tratada.

KEYWORDS | PALABRAS CLAVE

Gamification, transmedia, virtual-learning, careers, attitudes, innovation, e-learning, digital game-based learning.
Gamificación, transmedia, aprendizaje virtual, vocaciones, actitudes, innovación, elearning, aprendizaje digital basado en juegos.

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1. Introduction and current issues

The gradual introduction of information and communications technology (ICT) is the greatest challenge faced in education. As with any large-scale methodological change, it is not without controversy and is affected by a lack of resources, misinformation, and all kinds of resistance. Local education authorities, generally limited by scarce resources and a lack of creativity, advocate the convenient stance of "do it yourself", convincing teaching staff that it is part of their duty to innovate, learn new ICT tools, and introduce them into the classroom or school. It is often forgotten that the preparation and use of ICT require teachers to dedicate much more time compared with conventional teaching methodologies (Ferro-Soto, Martínez-Senra, & Otero-Neira, 2009): "the use of ICT can take away time that the teacher needs to carry out the teacher's other official tasks". Nevertheless, it is without any doubt that ICT offers enormous potential in the field of education, creating digital settings, collaborative learning, social mediation and encouraging cross-curricular learning, working on pro-social values and personal attitudes, leading to a less compartmentalised vision of curricular content. Considering ICT as educational tools involves understanding that they provide better channels of educational communication (Coll, Mauri-Majós, & Onrubia-Goñi, 2008). In fact, García-Valcárcel, Basilotta & López-Salamanca (2014) propose "the essential transformation of teaching practice, fostering the development of collaborative projects where ICT becomes a channel of communication providing the information necessary to guarantee learning scenarios which are open, interactive, rich in stimuli and sources of information, and at the same time motivating for the students, focussed on the development of competences".

Gamification is possibly the methodological tool that has received the most attention, and its introduction in education has been considered particularly relevant (Dicheva, Dichev, Agre, & Angelova, 2015; Wiggins, 2016). In recent years we have witnessed an explosion in the use of this term in specialised journals which present gamification as the new key methodology in education, in school settings and especially, in businesses (Prosperti, Sabarots, & Villa, 2016).

1.1. Elements of game-based learning

Gamification has traditionally been defined as the application of game-related elements in activities that are not games and in other contexts including, of course, education. Its main objective is to improve the intrinsic motivation of the participants. Several authors have focussed on different aspects of gamification. For Huotari and Hamari (2012) an important aspect is that gamification processes should evoke the same psychological experiences as games. Alternatively, Deterding, Dixon, Khaled, and Nacke (2011) have noted the importance of including the same features used in games in the gamification process, regardless of the outcome.

For Perrotta, Featherstone, Aston, and Houghton (2013) so-called Digital Game-Based Learning (DGBL) is developed according to essential principles and mechanisms that express its effectiveness. Perrotta indicates five such principles:

- Intrinsic motivation. Much more powerful than extrinsic motivation, intrinsic motivation comes from the willingness of the player to participate: the game invites and persuades people to participate. According to Pink (2011), intrinsic motivation is related to three elements that induce it, namely autonomy, competence, and purpose.
- Learning through intensive enjoyment. For one group of authors, led by Csikszentmihalyi (Nakamura & Csikszentmihalyi, 2009), gaming leads the participants into a flow (Csikszentmihalyi's Flow Theory), considered as a state of consciousness in which the individual has control over his or her actions while being completely absorbed in the task they are carrying out. Csikszentmihalyi points to eight components that enable flow: that the task is doable, involves concentration, clear objectives, feedback, effortless involvement, control over the actions carried out, the disappearance of one's consciousness and the loss of sense of time.
- Authenticity. Concern about the real nature of learning compared to more artificial decontextualised ways of traditional teaching. Priority is given to contextual abilities rather than abstract notions of formal learning. Learning processes based on specific practices.
- Autonomy. Playing games encourages independent exploration, bringing together personal interests and preferences, especially in one's surrounding ecosystem such as in technical and artistic skills (writing, drawing, music) while at the same time encouraging interest in gaining more information about other subjects, such as science or history.
- Experiential learning. Gaming makes it possible to handle situations in which "learning by doing" is a tangible, programmable and manageable option.

According to the literature about this subject, we can identify eight essential elements in the design of games that are usually applied in educational contexts (in DGBL):

• Points. These are a quantitative evaluation of the advances achieved by the player and are usually used as an immediate reward for his or her effort and as a proactive element in the evolution of the player in the game.

• Levels. Levels have normally been used to show the progression in the development of the game. They have been considered as synonyms of the grade of difficulty. The increase in level serves a purpose as a common reward in games, used when tasks or missions have been completed. It is very important to adjust the grade of difficulty for the transition between levels to prevent participants from dropping out or becoming demotivated (All, Nunez Castellar, & Van-Looy, 2014).

• Insignias and badges. These are considered as a visible sign of achievement obtained and aim to maintain the player's motivation at an adequate level for the following tasks (Gros & Bernat, 2008). Insignias are particularly effective to focus the player's interest in resolving future challenges or objectives (Chorney, 2012; Santos, Almeida, Pedro, Aresta, & Koch-Grunberg, 2013).

• Classification tables. These improve participant motivation, incentivising their performance in the game and is a way of improving positions. They show the participants' best scores and are regularly updated. According to O'Donovan, Gain, and Marais (2013), they increase the motivation of participants in educational gamification projects.

The Antarctic Project has been the first experience of specifically designed transmedia gamification carried out in Spain for its mass application. For this reason, in its initial design elements could be taken into account that would have been difficult to include using more limited means, such as the transmedia component, the specially designed programming, or the involvement of pro-science entities, to name a few.

• Prizes and rewards. The use of prizes and rewards in the game has been confirmed as a powerful motivator for participants (Brewer & al., 2013) and consequently, their timing in the game and the number of rewards obtained are of special relevance to players' motivation (Raymer, 2011). The rewards calendar should be adjusted in line with the educational content, the difficulty of the tasks and game levels, preventing possible areas of demotivation and tiredness (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2013).

• Progress bar. This shows the stage of development of the game, the level the player is on, how much he or she has advanced, and how much is left.

• Plot. The story behind the game which gives it meaning. Kapp (2012) suggests that a good plot helps participants to achieve an ever-increasing level of interest, keeping their attention throughout the game, increasing the chances of reaching the end and reducing "dropouts". The plot also provides a context that is very useful for learning, problem-solving, simulation and the like, making it possible to illustrate and practice the applicability of the concepts.

• Feedback. The information about the player's activity is given back to him. Its effectiveness will depend on its frequency, intensity, and immediacy (Raymer, 2011; Kapp, 2012; Berkling & Thomas, 2013). Higher frequency and immediacy are related to better results in the game-based learning process. Similarly, feedback is an important indicator of efficiency and immersion in the dynamics of the game (Domínguez & al., 2013).

Once the essential elements of a DGBL product have been configured, it is necessary to check how to strengthen its effects, and in particular, to identify the ideal area for its application (Foncubierta & Rodriguez, 2014).

1.2. The transmedia component

The narrative term transmedia was introduced by Henry Jenkins in 2003, in an article published in "Technology Review", in which he suggested that "we have entered a new era of the convergence of means which makes

it inevitable for contents to flow through different channels". According to Jenkins transmedia narratives are "stories told through a combination of means". For Scolari (2013), transmedia storytelling is "a particular narrative form that expands through different meaning systems (verbal, iconic, audiovisual, interactive, etc.)".

Following his article, Henry Jenkins defined the main principles of transmedia storytelling:

• Expansion vs. depth: Viral expansion through social networks vs. penetration in audiences until they become unconditional fans.

• Continuity vs. multiplicity. Continuity of expression of languages, means, and platforms vs. multiplicity of the creation of experiences starting from the initial plot.

• Immersion vs. extraction. Immersion in the proposed plot vs. extraction of the elements of the story to fit them into the real world.

• World building. Elaboration of characteristics that enrich and make the story realistic, such as details about the characters, the setting, etc.

• Seriality. Organization of the pieces and elements of the main story in a sequence that involves different kinds of media.

• Subjectivity. A mixture of multiple points of view regarding participating characters and plots of the core story.

• Performance. The consumers of the story can promote the main story even converting themselves into creators of similar or complementary contents (pro-consumers, according to Jenkins).

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The combination of principles of gamification and transmedia storytelling offers an educational universe with endless potential that fits in and corresponds to the profile of the user that we are dealing with in an educational setting: a multiplatform and an immersive user who can handle multiple tasks at great speed. The user prefers to personalise and manage his or her experiences, making them his or her own, actively participating in, and creating them. The passive teacher became history a long time ago.

1.3. Scientific promotion, attitudes, and pro-science careers

Public attitudes to science not only have an effect on performance in science subjects at school. They can also have an influence on the way society thinks and acts, its social image (and, consequently, the socioeconomic support for scientific research and programs), or the number of researchers or professionals in this field of knowledge (Pérez-Manzano, 2013). Together with this, the persistent decrease in interest in S&T careers is especially relevant (which has been confirmed in a report by the European Commission in 2004) and contrasts with the increase in the demand for S&T professionals.

The relationship between attitudes towards science and S&T careers is clear, and several findings have emerged as a consequence of the high level of scientific production generated about this matter:

• In the ROSE project (Schreiner & Sjøberg, 2004) it has been shown that there are "certain trends or regularities". For example, there is an inverse relationship between the stage of development of a country and the positive attitudes towards science in young secondary school students (Sjøberg, 2000); Schreiner & Sjøberg, 2005). The decline in pro-science attitudes firstly has consequences for the selection or rejection of subjects and scientific contents, and secondly, it has an effect on the number of professional careers chosen and even generates fixed personal attitudes that are either pro or anti-science.

• Career decision-making becomes stronger among those aged between 14-16 years, that is, those in the 3rd and 4th year of Compulsory Secondary Education (CSE) in Spain.

• The variable of gender is very relevant. Stereotypes, clichés, and social traditions arise when certain professions are related to this variable (Murphy & Beggs, 2003; Vázquez-Alonso & Manassero-Mas, 2009).

• An important component in the career decision-making of girls is the social benefit of the chosen profession as well as the contact with others as a result of carrying out this profession (De-Pro & Pérez, 2014).

2. Material and methods

In light of the aforementioned framework, we considered the need to carry out a project which would facilitate the promotion of scientific activity through a gamification development with transmedia support which could provide an immersive and participative experience.

We proposed the promotion of scientific-technological careers as our general objective by focussing on three components, usually identified in research into the topic as being essential for configuring a clear scientific and technological career:

• The career-decision motivations of active scientists.

• Interest in the real daily work of a researcher.

• The social benefit of scientific activity.

These would be reinforced by two complementary cross-curricular objectives: the management of scientific methodology and the knowledge of unique scientific and technical infrastructure (ICTS) linked to the Region of Murcia (the Hespérides Research Vessel and, therefore, the Antarctic bases) as well as the research carried out from them and their consequent social repercussions. The ICTS are front-line scientific installations at a national and international level that, by themselves, take up most of Spain's scientific budget and that, in several previous studies (Pérez-Manzano, 2013; De-Pro & Pérez, 2014) appear to be completely unknown to the general public and students of CSE in particular.

We assigned the name of "Antarctic Project" to this proposal. Once it had been designed and presented, its development was accepted by the Telefónica Foundation with the participation of the Local Education Authority of the Region of Murcia (through the Seneca Foundation, the Regional Science and Technology Agency) with the collaboration of the Spanish Polar Committee, the Spanish Army, and the Navy. An exclusive application of the project was offered to secondary schools in the Region de Murcia.

2.1. Methodology

The Antarctic Project consisted of a diverse set of tailor-made materials designed around and supporting a story that is able to attract the target population. It included the following components:

a) Storyline. Given that the whole development of the materials revolves around a storyline, its construction was very important, and the number of transmedia materials produced was determined by it. As the common thread, it was decided to narrate a situation in which different acts of sabotage had been carried out on the Hespérides vessel and the Gabriel de Castilla station to destroy scientific installations or active research development. The idea is passed on that there is a saboteur interested in eliminating the research activity in Antarctica. As the plot develops, the participants can appreciate the social relevance of the research carried out there as well as the fairly unethical activity on the Antarctic continent (indiscriminate tourist use or environmental deterioration). Careful consideration was given to the timeline of the plot to coordinate the contents, level of difficulty, news, communications, and other features.

A certain amount of responsibility was required in developing the plot which is a key aspect of a project of this nature to guarantee the level of immersion in the story used, reinforcing participation and reducing dropouts during the development of the project, and maintaining the interest and motivation of the participants over the three months that the Project lasted.

b) Web 2.0. For the system, a "web responsive" application was designed (adapted to smartphones and tablets) to allow access to the contents in an accessible and clear way. The web can be accessed by four types of user profiles: student, teacher, families, and pro-science centres (the latter is for personnel in museums, exhibitions, and scientific installations). The web environment has the main access to the control terminal from where there is access to relevant information such as:

• Active research: Eight real research projects were chosen from the 2014 and 2015 Spanish Antarctic Campaign. To select them, the curricular contents of the 3rd and 4th year of CSE in related subjects in the first term of the academic year were taken into account as well as their heterogeneity and repercussion on society.

Dossiers were included about antecedents, how to deal with this problem, the need for research, its results, and social effect.

• CVs of the participating characters: Information about each of the characters. Three types of character were constructed: researchers, military personnel, and civilians. We collaborated with eight real researchers responsible for each one of the selected research projects, showing an informal CV for each with personal details, hobbies, their reasons for choosing research as a profession, etc. as well as a contact email address on the platform which could be used to ask them real doubts about their work as a researcher. Similarly, the CVs of the real military personnel of the active campaign were included, three from the Hespérides vessel, and three from the Gabriel de Castilla station. As civilians (not real ones), two protagonists were designed and three civilians completed the story.

• Installations: access to the game in the Hespérides vessel and the Gabriel de Castilla station, four scenarios in each one of these, perfectly recreated using photographs of these.

• Video blogs: weekly audiovisual reports to support the plot.

• Ranking: a table was completed with the ten best individual scores and for each school.

• Tasks: problems of a scientific nature to be resolved according to the needs of the story.

• News: a news bulletin that updated the story daily as the plot unfolded.

c) Game. Eight interactive scenarios were designed in a game format. Of these, four corresponded to the Hespérides and four to the Gabriel de Castilla station recreating real scenarios based on illustrations taken from photographs provided by the Army and Navy as a basis to work on. In each one of them, a scientific-type online challenge was planned to be carried out using the digital materials available in the available scenarios. Each scenario was coordinated according to the calendar, the research to be carried out, and the difficulty ratings of the game. At the start of the game, two scenarios were available (one in the Hespérides and another at the station) so that, depending on progression in the dynamics of the game, the other scenarios could be unlocked and points obtained.

In the different scenarios, elements were collected and combined so that it was possible to resolve the online challenges proposed (assay tubes, eyepieces, black light torch, etc.).

d) Protagonists. Two profiles were designed for the protagonists attending to the characteristics of the target population of the 3rd and 4th year of CSE paying special attention to the combination of pro-science interests, very up-to-date interests, and those that the target group could identify with. Boys and girls, students from Secondary Schools in the Region, both collaborated with the research teams of the Campaign. The two characters had profiles on social networks and undertook active communication with the participants (https://goo.gl/9vubBd).

e) Webisodes/video blogs. Fictional audiovisual materials with actors representing the protagonists and a post-production phase highlighting dramatized situations were coordinated with the story as triggers of moments in the story, generating or making way for problems that the participants had to decide how to resolve, choosing different alternatives before continuing. They can be seen on https://goo.gl/s76E6Q.

f) Challenges, tasks, and S&T curricular content. Obtaining points, insignias, or rewards were established attending to the two types of problems to be resolved. On the one hand, the online challenges were resolved in each scenario of the game (for example, analysing tissue samples from a penguin) providing individual scores. Once the challenge had been resolved, the weekly task was activated, a problem to be resolved similar to those seen in related subjects (resolving a ship's steering angle needed to avoid a collision), and the answer to the challenge had to be entered while playing the game. Based on performance on these tasks, the score for the schools was obtained (scored according to the number of students in the 3rd and 4th year of CSE in the school). Only by resolving challenges and tasks was it possible to go to the next level. Both were published on Mondays at 9 a.m., with the activation of the corresponding video blog, reducing the points to be obtained in the following days. Support messages were programmed to be sent to the participants' mobile phones and their twitter account. Similarly, if no response had been given by Thursday, a new videoblog was activated with clues to resolve the weekly challenge.

The complementary materials for the classroom designed using the curricular contents of the scientific subjects studied in the first term by the students on this project were aimed at: Natural sciences (3rd year CSE), biology and geology (4th year CSE), physics and chemistry (4th year CSE).

1) Extra teaching materials (for teachers, families, museums, ICTS). Materials to be used in the classroom were designed based on the curriculum contents of the 3rd and 4th years of the aforementioned subjects. A prior training activity was carried out for the teachers interested in participating (with more than 80 enrolled). As part of this activity, they were informed how the platform could be used. The teacher profile allows for the follow-up of students in his or her classes, monitoring of the results, errors, evolution, rewards, and other indicators.

Similarly, materials for families were designed using simple resources to develop contents or carry out experiments with homemade materials, and the like. These materials were distributed with plenty of time through the parent associations at the schools. Finally, the materials for pro-science schools (ICTS-Science Museums) were a collection of different resource packs organised in connection with the subject area of the project to create and revitalise workshops and visits.

2) Social Dynamics. Profiles were designed on the social networks of the protagonists of the story to complement it and make it more dynamic. A timeline was constructed for the communications made via social networks between the protagonists and participants, which was informal and mechanised, and linked to individual evolution in the game. The system made publications on Facebook or Twitter depending on weekly activity according to the story-line.

3) Values and attitudes. Having taken into account the previous relevance of attitudes and values in career decision-making, special care was taken in showing very up-to-date pro-science attitudes in the protagonists with common personalities and interests among the group. These were related to the real personalities of the scientists, attempting to move away from stereotypes about their image. The plot highlights the social benefits of the research done there, as well as the importance of taking care of the environment.

2.2. Study sample

Just as we have mentioned previously, the project was proposed to the Autonomous Community of the Region of Murcia, offering participation to all the secondary schools in the region through a public call for expressions of interest by the Local Education Authority. A maximum of 1,741 active students participated in the project resolving tasks and challenges every week (in addition to 465 teachers and 49 secondary schools). From these students, 100 participants were chosen at random to respond to an online survey with five questions at the beginning and the end of the project.

2.3. Procedure

The following questions were posed to the 100 selected participants:

- Have you heard about the research carried out by Spain in Antarctica?
- Do you know what takes place on the Hespérides vessel and at the Gabriel de Castilla station?
- Do the Army and Navy collaborate in the research carried out by Spain in Antarctica?
- Rank from 1 to 10 the benefit that you believe the research carried out in Antarctica provides for Spain?
- Would you like to be one of the scientists who do research work in Antarctica?

3. Analysis and results

An analysis was carried out of the different participants' access to the game and the resolution of the set challenges. The number of participants has been fairly constant, with mean weekly access of 1,503 students. It has been very useful to check how the number of entries in the last week is higher than in the first, suggesting the addition of participants once the project was underway. All of these indicators highlight that two elements of the project are working.

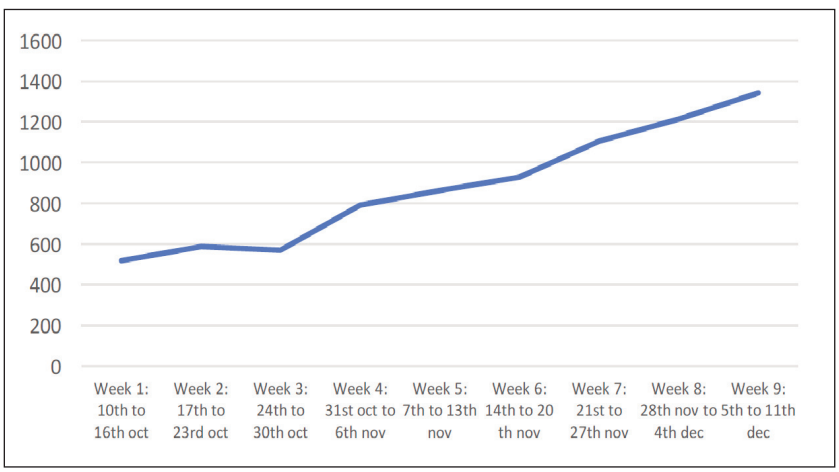

Figure 1. Mean Time.

- The distribution of the contents and scaled levels subject to overcoming tasks. This has made it possible to

maintain interest from week to week, "enticing" the users much more than if they had been shown all the scenarios and contents at the same time.

• The efficiency of the plot and scripting of the contents, meaning that one of the highest levels of entries took place the week it was resolved, with the identification of the guilty person. This was a good indicator of the immersion of the participants in the constructed story.

One important aspect regarding this information is the mean time dedicated by the participants to stay in the game. The mean staying time is directly related to the rate of difficulty. Therefore, its graphic representation should coincide with a fairly gradually ascending line. The data is shown in Figure 1.

As can be seen in the Figure, the line slowly increases so that the average time in the end doubles the average at the beginning. In light of this increase, we can see that the level of difficulty was correct regarding the development of an approach to the contents of the Project. We shall now analyse the data obtained by the selected sample in the pre- and post-project survey.

In Figure 2, we can see that initially, 18.7% of the participants knew about the research developed by Spain in Antarctica. After participation in the project, 100% knew about this work.

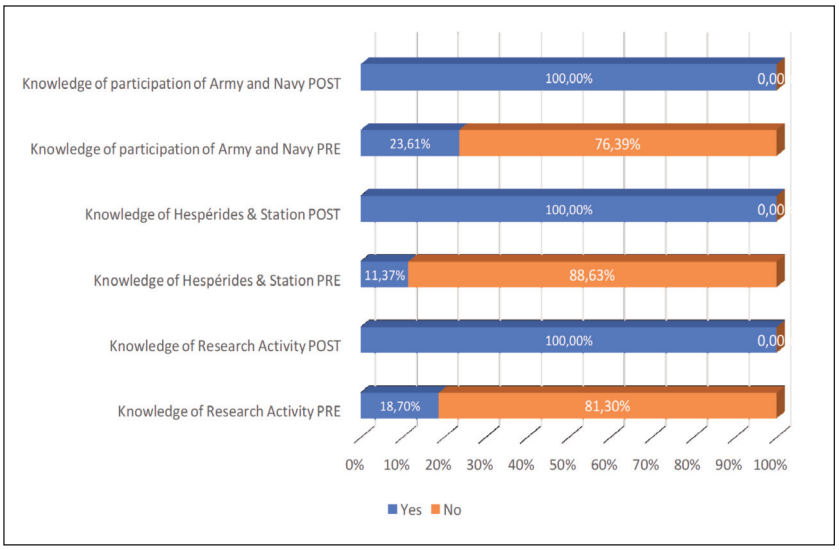

Figure 2. Evolution of Previous Knowledge.

As in the previous question, we analysed the participant's knowledge of the activity of the Hespérides and the Gabriel de Castilla station. Before participation in the project, 11.37% of them knew about it whereas, after participation in the project, 100% understood about this participation.

Likewise, the work of the Army and Navy in management, logistics, and in general support in the Spanish research work in Antarctica is usually quite unknown, and therefore it is interesting for us to find out about their previous knowledge and their evolution in the project. In Figure 2, we can see how only 23.61% of the participants stated knowing about the military and naval collaboration before the project. After participation, this percentage reached 100%.

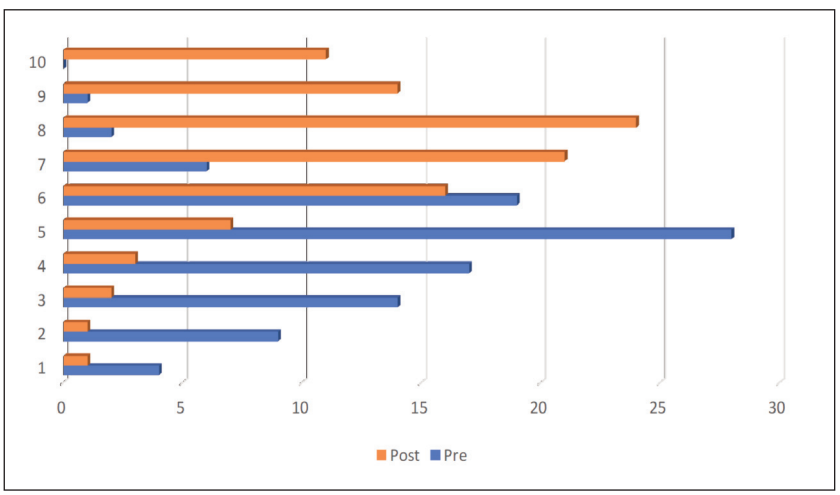

Figure 3. Assessment of the social benefits of Antarctic Research.

In this question, we observed scores (from 1 to 10) taken from the sample about the possible social impact of Antarctic research. As we can see, the pre-project assessment is quite harsh, with a mode of 5, and where

the vast majority of scores are displaced towards the lowest scores. This contrasts with the post-project scores, where the mode is 8, and the score curve is displaced towards the upper zone.

This is probably the most anticipated question of those posed, assessing the effect of the project on the participants' interest in S&T careers. As we can see in Figure 4, previous interest in scientific professions was 9.39% in the pre-project sample, and after participation in this project, this percentage rose to 34.16%. We can see how professional interest in S&T has gone up very significantly.

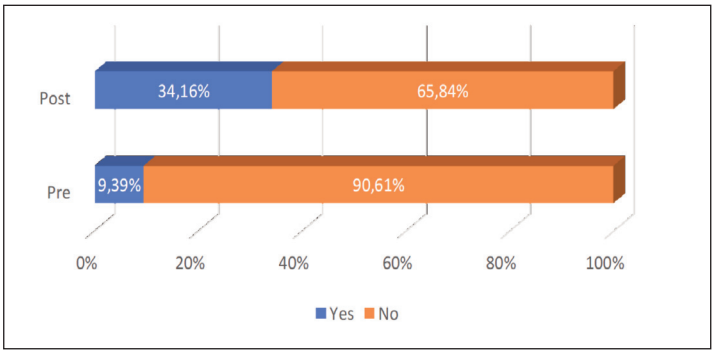

Figure 4. Interest in Becoming a Scientist.

4. Conclusions

Our general approach to the proposal was to follow a central element in gamification; according to (Hamari & Koivisto, 2013) "the main objective of gamification is to have an influence on people's behaviour, regardless of other secondary objectives such as people's enjoyment while taking part in the activity of the game". Our proposal intended to go beyond the proliferation of game design elements that arise from the "do it yourself" techniques that we discussed at the outset. The limitations of this type of development are clear, restricting its reach, effects, and possibilities. The Antarctic Project has been the first experience of specifically designed transmedia gamification carried out in Spain for its mass application. For this reason, in its initial design elements could be taken into account that would have been difficult to include using more limited means, such as the transmedia component, the specially designed programming, or the involvement of pro-science entities, to name a few.

In the structure shown in Figure 5, we have considered the participation of all the players involved, each of them for different reasons. Institutionally, it is essential to coordinate scientific promotion campaigns among ICTS, science museums, fairs, and schools as a way to make the most of their efforts and to harmonise their interests, needs, shortcomings, and expectations. In scientific promotion and communication programs, it is necessary for scientists to be present as a way to eliminate classic stereotypes that persist today (scientist = clumsy, badly-dressed, not at all modern, etc.). The proximity of this group, its togetherness (the participants exchanged emails with the researchers about doubts and comments about their work), its interest of their work for society, etc. are key elements that were very evident in the program design.

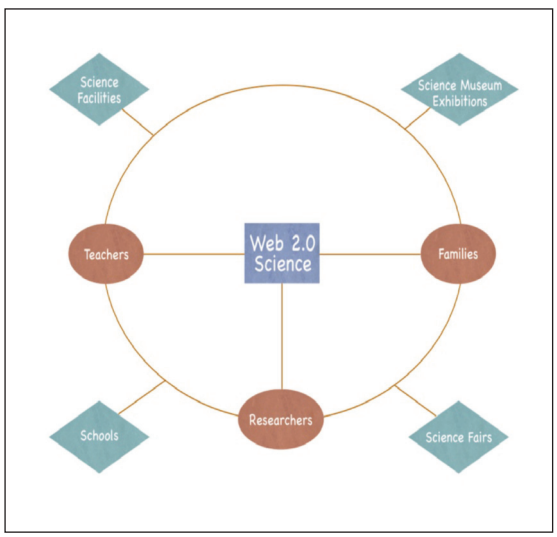

Figure 5. Model of Scientific Education.

In light of the results, we can confirm that we achieved the objectives we aimed at initially. The participants have had the opportunity to find out about the motivations for career-choices of active scientists and to see the interest and social benefit from research work in general while handling scientific methodology and learning about the work carried out at an ICTS. The previous lack of knowledge of Spanish research activity in Antarctica, the work of the Hespérides and the station, or the essential support of the Army and Navy are concerning and point toward the lack of knowledge affecting the heart of S&T actions and policies in Spain and, therefore, the decrease in demand for careers in this field. In this regard, our general objective of fostering vocational interest in S&T professional fields has been fulfilled with a clear and very relevant effect on the participants.

The use of elements close to the target user is of particular importance for achieving our objectives. It is essential to have an attractive storyline and, above all, to have protagonists the participants can easily identify with regarding likes, hobbies, and preferences. The use of messaging and publications on the protagonists' social networks has greatly helped to increase the participants' immersion and make the plot realistic. To do this, we must not forget the importance of illustrations and designs, a realistic reflection of real-life scenarios, even the complete 3D design of the Hespérides vessel and the Gabriel de Castilla station.

By carrying out this project, we have charted an especially interesting path for local authorities to carry out specially designed gamification programs with transmedia support, involving all the players in a common and coordinated effort. The initial financial cost is quickly overcome in the following years, repeating the story in different groups of students, or only changing the plot and characters. A project of this nature can make way for changes in the story by multiplying different developments that use the same core software. The efficient use of public investment in these tools is inevitable if we want to implement efficient and innovative technology in education that goes beyond isolated individual experiences.

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