Player Profiles in Science Education for Game-Based Digital Training Actions at the University Level

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***Abstract*—Gamification in education applied to digital learning environments is undergoing an intense development in recent years at all educational levels, including higher education. The success of this type of didactic actions is linked to a good match between the player profile designed by the professor and the student's own player profile. In this paper a descriptive analysis is made of the player profiles with which higher education professors of science areas identify themselves and which ones they consider to be more conducive to learning in this specific field of knowledge. For this purpose, Bartle's traditional classification of player profiles (Killer, Explorer, Socializer, and Achiever) has been used, and a questionnaire has been sent to a sample of university professors from scientific areas. The responses to this questionnaire have been statistically analyzed. The results reveal that the most common player profile among the participating science professors is Explorer, which is also considered to be the most suitable for learning. This majority choice of the Explorer profile is higher, in proportion, among science professors with previous experience in gamification. In addition, male science professors identify more than females with the most competitive player profiles (Killer and Achiever). Finally, some implications and recommendations derived from the results are described.**

***Index Terms*—Digital learning environment, gamified learning, player types, science education**

I. Introduction and Literature Review

The use of gamification in education consists of the introduction of game techniques or resources, such as obtaining bonus, points, and badges, and the establishment of classification tables, within the teaching-learning dynamics [1, 2]. In recent years, the inclusion of playful elements in digital learning environments at different educational levels has been increased [3]. Among the environments that can incorporate gamified elements are artificial intelligence resources [4, 5], digital learning platforms [6], cloud-assisted learning [7], or virtual reality environments [8, 9]. In the specific case of higher education, which is precisely the subject of the present study, research works are mainly focused on the design and evaluation of gamified situations into e-learning [10]. This is applied to different areas of knowledge, such as technical fields [11, 12], scientific subjects [13, 14], or humanities and social sciences [15]. In addition, university professors highlight the lack of training they have, in general, in the use of educational gamification techniques, although they recognize that gamification encompasses certain traditional didactic strategies [16].

The main objective of introducing gamification in digital learning environments is to increase student motivation. This is due to the immersive nature of game-based learning environments [17, 18]. Different studies have proved that the effectiveness of gamified teaching strategies in terms of motivation and immersiveness is greater the more adapted the design of the situation to the personality of the students [19, 20]. For example, it has been proved that the degree of introversion or extraversion of the students influences the type of gamified techniques that will be most suitable for learning [21].

However, there are studies that question the existence of sufficient empirical evidence of the benefits of gamification for learning and encourage further research in this regard [22]. Specifically, most publications on educational gamification focus on theoretical developments and reviews, designs of gamified environments, and the establishment of connections between gamification and personalized learning, but research on the didactic benefits of gamification is perceived to be scarce [23]. Moreover, the evolution of the use of educational gamification is reviewed [22], concluding that the research being done in this regard does not reach the magnitude of educational practice in gamified environments that is currently taking place. Furthermore, the review conducted by Koivisto and Hamari [24] concludes that research on educational gamification is, in general, misguided and lacks clear lines. In addition, there is a notable lack of skills among teachers to design gamified didactic situations [22].

An aspect observed by the review papers on educational gamification is that the different gamified strategies are used with very unequal frequency, the most common being designs that make use of competitive resources such as points or classification tables [24]. This is an important aspect, because the type of user experience affects the learning generated by the gamified situation. In turn, this reveals the need to analyze the player profiles of those who design the game and those of the potential users, to optimize the design of gamified situations in terms of achieving the learning objectives.

The design of gamified learning strategies that adapt to the personality characteristics of students requires knowledge of the different player profiles that can be found in these gamified situations. The most used classification of player profiles in the literature is that of Bartle [25]. This classification establishes the existence of four player profiles or player types: Killer, Explorer, Socializer, and Achiever. Killers seek victory and their actions are aimed at removing the rest of the players. Therefore, they feel comfortable when interacting with other players, but in strongly competitive terms. Therefore, they perceive the other players as an enemy or an impediment to the achievement of their own goals.

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Explorers rather enjoy interacting with the world, discovering new environments and situations, and understanding new realities and mechanisms. This profile is linked to the experience of discovery, rather than to the experience of interaction with other players. Socializers prefer, like Killers do, the interaction with other players but, unlike them, they engage in constructive, rather than competitive, peer-to-peer interaction. Therefore, the game is for them a way to meet other people, inside or outside the game. Achievers seek interaction with the environment to win points or tests. This objective leads them to develop winning strategies, for which they may or may not interact with other players.

Bartle's classification [25] focuses on categorizing the players of a multiplayer MUD (Multi-User Dungeon) game, and, by extension, the Massively Multiplayer Online Role-Playing Game (MMORPG) [26, 27]. The MUD is a text-based adventure game whose development is built on the interaction of users in real time. The analysis of the player profiles of the gamers is based on data obtained from a discussion forum about their game preferences in the virtual world, their interactions with other players, and their perceptions about the interests of the rest of the players. Bartle's original description is illustrated by a graphical scheme of two axes of play style (action versus interaction with other players and with the environment). This representation assigns players according to their preference for interaction with the rest of the players or with the surrounding environment within the game. Thus, the player profiles are distributed in the different quadrants defined by the above axes (Fig. 1).

Fig. 1. Player profiles according to Bartle's original classification, in terms of their level of action and interaction with other players and with the environment.

After the publication of the original classification, Bartle [28] designed an extended version of the model of player profiles. This new taxonomy includes implicit or explicit motivation as a new axis, which is independent and transversal to the previous ones. This leads the definition of eight types of players: Griefer, Opportunist, Politician, Planner, Friend, Hacker, Scientist, and Networker. This classification aims at incorporating new characteristics of user psychology and personality to give an increasingly refined description of player profiles. However, such broad classifications have the disadvantage that the same person could have characteristics of more than one player profile, which makes it difficult to attribute a player profile to a player.

The literature includes other taxonomies for player profiles. Among them, Marczewski's typology test [29] considers the different personalities of the players. However, it is a less fine classification than Bartle's [25] because it distinguishes only three player profiles: Free spirit, Philanthropist, and Disruptors. Likewise, Tondello *et al.* [30, 31] developed a taxonomy for player profiles, called Gamification User Types HEXAD, based on the motivation that different players may have within the game development. This classification describes six player profiles: Achiever, Disruptor, Free spirit, Philanthropist, Player, and Socializer. Each of these profiles is characterized, respectively, by the following aspects: mastery, change, autonomy, purpose, reward, and relatedness. However, in this work, Bartle's classification [25] has been used, because it is the most common and is the foundation of most of the studies on gamification [32]. Moreover, it is a simple enough classification for study participants to distinguish the different profiles well enough to make confident profile choices (it is not as fine-grained as HEXAD, which might make participants hesitant to distinguish between different profiles). In addition, Bartle's classification provides a framework for understanding player profiles in relation to player personality that is both comprehensive and easy to handle.

The adaptation of the gamified situations to the player profiles of the students allows a better development of the gamification situation [33], an increase in the motivation of the students towards learning [34], and a better predisposition of the students towards the development of the activities of the lectures [35]. In general, the studies that analyze the player profile of university students assure that the most common profile among them is that of Achiever, whether Bartle's [36, 37] or Marczewski's [38] classification is used. This is consistent with the motivational elements that most frequently have a positive influence on the participation and use of gamified activities by students. These are the achievement of partial and progressive objectives, the obtaining of scores, and the evolution of some type of progress bar [39].

Although the Achiever profile is the most common among higher education students, it has been proved that the gender of the gamers influences their player profile. Specifically, males express, in general, higher levels of motivation around gamified situations than females. They also identify in greater proportion with the most active player profiles (Killers and Achievers) than females [31, 40]. However, the literature also reports that female students increase their academic results to a greater extent than males when they use gamified environments [41].

There may be a gap between students' player profiles, professors' player profiles, and the most suitable player profiles for learning acquisition according to the area of knowledge, as the third person Point Of View (POV) perspective assures [42]. This suggests the need to describe, not only the students' player profiles, but also those of the professors and their perceptions about the most suitable player profiles for learning, to have tools for an adequate design of gamified situations.

Although the literature is not specifically concerned with analyzing the differences between the player profiles of professors and students, this analysis has been carried out in the case of engineering professors in a pioneering work in this regard [43]. This work explains that engineering professors are mostly Explorers and very few Achievers, according to Bartle's original classification [25]. This proves the existence of a strong gap between the player profiles of professors and students in the engineering area. Moreover, the proportion of engineering professors who believe that the Explorer player profile is the best for learning is even higher than that of those who identify with this player profile. On the other hand, there is a certain proportion of Socializers and Achievers who, when choosing the best player profile for learning, choose a player profile different from their own. Therefore, there is a gap among engineering professors between their own player profile and the one they consider most suitable for learning. It is also found that, among male professors, the presence of Explorers is greater, in proportion, than among females. Therefore, the gender of the professors is proved to be an influential variable in the self-concept of the player profile. The age of professors is also influential on player profile choices in engineering. Specifically, the choice of more competitive player profiles, such as the Achiever profile, decreases with increasing age, while the choice of less competitive profiles, such as Socializer, decreases with increasing age [43]. These results contrast, however, with the perceptions that, in general, professors present towards gamification strategies. Indeed, no significant differences by gender or age have been identified with respect to the perceptions about the use of gamification strategies [44]. From all the above, it is concluded that it is necessary to harmonize the three previous perspectives (player profiles of the students, of the professors, and the most suitable for the learning of the specific subject) to increase the quality of the design of the gamified situation.

The above descriptions and analyses cannot be extended, in principle, to professors in areas of knowledge other than engineering, because the area of knowledge strongly conditions the perception of professors on any design of a didactic strategy in digital environments [45, 46]. Specifically, as far as it has been possible to explore, no research articles published in journals indexed in Scopus have been found that make a complete analysis of the player profiles of professors in science education, even though the employability and effectiveness of gamification techniques in science education [13], although there may be papers that approach the issue from a specific science subject [47]. In fact, a Scopus search of research papers containing the terms "Gamification" and "Science Education" in the title, abstract, or keywords allows to assume that, in the last decade, there is a growing trend in the interest of researchers in gamification strategies in science education (Fig. 2). On the other hand, another search string in Scopus defined as ("gamification" and "player profile" or "player type") shows the same trend of interest in the study of player profiles in the last decade (Fig. 2). All this proves that there is a growing interest in the analysis of player profiles, but that the subject is very new and still has a long way to go for researchers. However, despite the growing trend in publications, the number of papers is still small in absolute terms. Indeed, none of the articles published in the last decade on gamification in the specific area of science education contains the expression "player profile" or "player type" in its title, abstract, or keywords. This proves that the present research work is completely original in the field of player profiles analysis in science education.

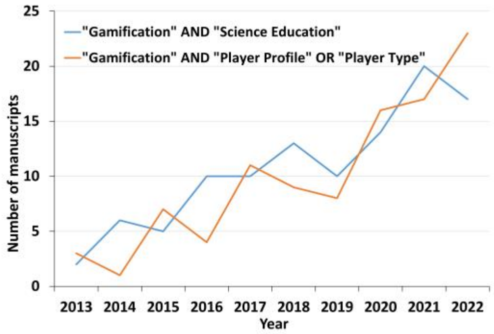

Fig. 2. Articles indexed in Scopus (decade 2013-2022) that follow the two search strings: (i) "gamification" and "science education"; and (ii) "gamification" and "player profile" or "player type" in the title, abstract, or keywords.

This research presents an analysis of the player profiles of science professors from universities in the Latin American and Caribbean region and their perceptions of the most suitable player profile for learning through gamified situations. Therefore, the main novelty of the present study lies in the analysis of the player profiles of university teachers of scientific subjects, as distinct from previous studies focused on other areas such as engineering, or on specific scientific subjects.

The general research objective of the present work is to study the self-concept of player profile of science professors, following Bartle's [25] classification. Their perceptions about which is the most suitable player profile for science learning in gamified situations is also analyzed. Specifically, the following specific objectives are sought: (i) to identify the most frequent player profiles among science professors; (ii) to analyze which are the player profiles chosen by the participants as most conducive to learning and whether there are significant differences between this choice and the self-concept of player profile of science professors; (iii) to identify gender gaps, both in the player profile of the science professors and in their choices of best player profile for learning; and (iv) to analyze the influence of age and previous experience in the use of gamification by the science professors on their choices of player profiles, and whether these influences are affected by the gender of the professors.

II. Methods

A. Participants and Data Collection

The target population was made up of Latin American science professors. The delimitation of the participants' areas of knowledge is given by the category "Natural Sciences, Mathematics and Statistics" of the UNESCO classification of areas of knowledge [48], which includes biology and biochemistry, environmental sciences, chemistry, physics, earth sciences, mathematics, and statistics. The participants were chosen by a non-probability sampling process for convenience among registered attendees to a training lecture on educational gamification in higher education repeated biweekly by the authors between January and June 2022 with the following objectives: (i) to present the applications of gamification in higher education; (ii) to expose in a theoretical-practical way Bartle's classification of player profiles in educational gamification. This was a single two-hour session, repeated, with different attendees, every two weeks over the six-month period indicated. During the session, which was developed as a master class, the main theoretical concepts related to educational gamification were presented, including the description of player profiles according to Bartle's classification. In addition, the authors developed some practical examples of the application of educational gamification in higher education, but the attendees did not themselves develop practical exercises in this regard. However, from the theoretical explanation and description of the cases, it can be assumed that the professors had a sufficient and homogeneous knowledge about gamification and player profiles at the time of participating in the study. A total of 512 science professors attended the training lecture. After the session, the questionnaire used as a research instrument was sent to the attendees by e-mail.

The criteria for inclusion in the study were the following: (i) being an active science professor at a university in Latin America and the Caribbean; and (ii) having attended the described training session on gamification. All the professors contacted responded to the questionnaire and all the answers were validated in the sense that they were complete. All the participants knew the research purposes of their participation and gave their express consent for it. Likewise, the research always followed the stipulations of the Helsinki Declaration, the participation of the professors was voluntary, free, and anonymous, and no data was collected that would allow the identification of the participants. Also, gender (female or male), age, previous experience in the use of educational gamification (yes or no), and country of origin were asked in the questionnaire. A total of 512 Latin American professors from science areas (35.5% male, 64.5% female; mean age 47.5 years old, sd = 10.3, median age 50 years old) from 19 different Latin American countries (Fig. 3). Therefore, there is a significant majority of females. The interquartile range of ages is 20 years. No professor is under 30 years old and only 25% are over 60 years old. The distribution of participants by country is not homogeneous (Fig. 3), being Argentina, Chile, Colombia, Ecuador, Mexico, and Peru the ones that bring together a higher proportion of participants (almost 80% of the participants among the six countries).

Fig. 3. Distribution of participants by country.

Among females, approximately half have experience in the use of gamification in their lectures, while among males, only approximately a third have experience in gamification (Fig. 4). These differences in the distribution of gamification experience between genders are statistically significant ($\chi^2 = 7.15$, p-value = 0.0075).

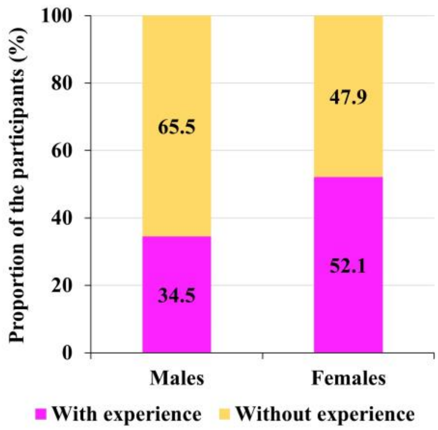

Fig. 4. Distribution of participants (%) by gender and experience in the use of gamification.

B. Research Variables and Instrument

Three independent variables are considered in the study. The main independent variable is the gender of the participants, which is nominal dichotomous (female or male). The secondary independent variables are the age of the participants (which is quantitative) and whether they have previous experience in the use of gamification in their lectures (which is nominal dichotomous). The dependent variables are the player profile with which the participants identify themselves and the player profile they value as most suitable for learning. Both are polytomous nominals, with four possible values, which correspond to the four player profiles of Bartle's classification (Killer, Explorer, Socializer, and Achiever).

A questionnaire of two questions was used as a research instrument in which the participants chose: (i) which player profile they identify with; and (ii) which they would choose as the most favorable for learning. All questions are multiple choice and single answer. The content validity of the research instrument has been checked in previous work [43].

C. Statistical Analysis

In this research, a quantitative analysis of the player profile choices made by the participating science professors is carried out. Specifically, an analysis of the proportions of the responses and the influence on the choices of player profile of the gender and previous experience in gamification is carried out. The Pearson chi-square test of goodness-of-fit to homogeneous distributions was used to identify significant differences between the choices of the different player profiles. In addition, the Pearson chi-square test of independence was used to check the influence of the gender of the participants and their previous experience in the use of gamification in the choices made for the player profile. The identification of gaps based on the age of the participants was carried out using the Analysis Of Variance Test (ANOVA) for comparison of mean ages and the Levene's test for comparison of variances. All hypothesis contrast tests have been performed with a significance level of 0.05.

III. Results

Almost half of the participants identify with the Explorer profile, and almost a quarter identify with the Socializer profile (Table I). The Killer and Achiever player profiles are the least frequent. However, the proportion of those who consider Explorer to be the best player profile for learning exceeds 50% and is 8.79% higher than the proportion of Explorers among the participants. In contrast, the Socializer and Achiever player profiles are chosen as suitable for learning in a smaller proportion than they are chosen as their own player profiles (specifically, the decrease is 11.10% and 40.28%, respectively). The proportion of those who choose the Killer player profile as the best for learning is 13.67% higher than the proportion of Killers among the participants (Table I).

TABLE I: Distribution of Participants' Responses (%) (K: Killer, E: Explorer, S: Socializer, A: Achiever)

	K	E	S	A	χ^2	*p*-value
Participant's player profile	17.05	48.45	24.42	10.08	86.28	<0.0001
Best player profile for learning	19.38	52.71	21.71	6.02	120.11	<0.0001

More than half of the Killers, Explorers, and Socializers choose the Explorer profile as the most conducive to learning in the science areas (Table II). This proportion rises to almost 60% in the case of Killers. For the Achievers, the choice of the best profile for learning is distributed mostly and homogeneously among the Killer, Explorer, and Socializer player profiles (Table II). The gap between the player profiles of the participants and the player profiles chosen as best for learning is statistically significant (χ^2 = 16.98, *p*-value = 0.0490).

TABLE II: Distribution of the Player Profiles of the Participants and the Choices of Player Profiles Considered Most Suitable for Learning (%)

		Best player profile for learning			
		Killer	Explorer	Socializer	Achiever
Participant's player profile	Killer	27.3	59.1	4.5	9.1
	Explorer	16.0	56.8	22.4	4.8
	Socializer	15.9	49.2	28.6	6.3
	Achiever	30.8	30.8	30.8	7.6

There are no statistically significant differences in the distributions of the player profiles between males and females (χ^2 = 1.96, *p*-value = 0.5806). However, there is a significant gender gap in the choices of the best player profile for learning (χ^2 = 12.42, *p*-value = 0.0061). Specifically, female professors choose the Explorer player profile 40.9% more than males and the Socializer player profile 54.3% less than males (Table III).

TABLE III: Distribution of the Player Profiles of the Participants and Player Profiles Chosen as most Suitable for Learning, Distinguishing by Gender (%)

	Participant's player profile		Best player profile for learning	
	Males	Females	Males	Females
Killer	20.2	15.4	18.0	20.1
Explorer	48.3	48.5	41.6	58.6
Socializer	20.2	26.6	33.7	15.4
Achiever	11.2	9.5	6.7	5.9

The analysis of variance test does not identify significant gaps between the mean ages of science professors who identify with the different player profiles nor between the mean ages of those who choose each player profile as more suitable for learning, neither among males nor among females (Table IV). Therefore, it can be assumed that age is not a significantly influential variable in the responses. However, Levene's test of variance comparison prove that, among the male professors, the ages of the Achievers are more uniform than the ages of the rest of the participants. Among females, on the other hand, no significant differences are found in the age deviations (Table V).

TABLE IV: Mean Ages of the Respondents According to Their Player Profile and to the Choice of Player Profile more Suitable for Learning, and Statistics of the ANOVA Test of Mean Comparison

		Males		Females	
		Mean age	ANOVA	Mean age	ANOVA
Participant's player profile	Killer	48.89	0.43 (p = 0.7334)	43.08	1.39 (p = 0.2555)
	Explorer	47.67		48.05	
	Socializer	51.11		47.11	
	Achiever	48.00		46.25	
Best player profile for learning	Killer	48.75	0.27 (p = 0.8460)	49.41	1.27 (p = 0.2985)
	Explorer	48.38		46.87	
	Socializer	49.33		44.62	
	Achiever	46.67		44.00	

TABLE V: STANDARD DEVIATIONS OF THE AGES OF THE RESPONDENTS ACCORDING TO THEIR PLAYER PROFILES AND TO THE CHOICE OF PLAYER PROFILE MORE SUITABLE FOR LEARNING, AND STATISTICS OF THE LEVENE'S TEST OF VARIANCE COMPARISON

		Males		Females	
		SD (age)	Levene	SD (age)	Levene
Participant's player profile	Killer	11.32	2.76 (p = 0.0433)	10.87	0.63 (p = 0.6326)
	Explorer	11.30		10.48	
	Socializer	11.32		8.69	
	Achiever	4.22		10.25	
Best player profile for learning	Killer	8.06	2.73 (p = 0.0489)	11.27	0.65 (p = 0.5827)
	Explorer	10.93		9.76	
	Socializer	12.58		8.59	
	Achiever	5.16		12.65	

The Explorer player profile is 35.35% higher among science professors with previous experience in gamification than among those without. Likewise, the proportion of Achievers among those with gamification experience is 36.78% higher than among those without. On the other hand, there are fewer Killers and Socializers among those with experience in using gamification than among those without (Table VI). The influence of previous experience on the self-concept of the player profile is statistically significant (χ^2 = 8.69, p-value = 0.0337). However, experience in the use of gamification does not significantly influence the choice of the best player profile for learning (χ^2 = 2.69, p-value = 0.4420).

There is a gender gap in terms of the influence that previous gamification experience has on the player profile with which science professors identify. Specifically, this experience influences the player profile of males (χ^2 = 9.39, p-value = 0.0245), but not that of females (χ^2 = 1.05, p-value = 0.7903). Within the males, the proportion of Explorers among those with prior gamification experience is almost double the proportion of Explorers among those without. However, the proportion of Killers is just over half and the proportion of Socializers is about a quarter (Table VII). The proportion of Achievers is roughly similar for experienced and inexperienced participants. In contrast, the choice of the best profile for learning is not significantly influenced by previous gamification experience, neither among males (χ^2 = 3.34, p-value = 0.3418) nor females (χ^2 = 2.14, p-value = 0.5429).

TABLE VI: DISTRIBUTION OF RESPONSES ACCORDING TO WHETHER PARTICIPANTS HAVE PREVIOUS EXPERIENCE IN THE USE OF GAMIFICATION IN THEIR LECTURES (%)

	Player profile	With experience	Without experience
Participant's player profile	Killer	11.9	21.7
	Explorer	55.9	41.3
	Socializer	20.3	28.3
	Achiever	11.9	8.7
Best player profile for learning	Killer	15.3	23.2
	Explorer	55.9	49.3
	Socializer	22.0	21.7
	Achiever	6.8	5.8

TABLE VII: DISTRIBUTION OF RESPONSES ACCORDING TO WHETHER PARTICIPANTS HAVE PREVIOUS EXPERIENCE IN THE USE OF GAMIFICATION IN THEIR LECTURES, DIFFERENTIATING BY GENDER (%) ("WITH" MEANS WITH EXPERIENCE AND "WITHOUT" MEANS WITHOUT EXPERIENCE)

		Males		Females	
		With	Without	With	Without
Participant's player profile	Killer	13.3	24.6	11.4	19.8
	Explorer	66.7	36.8	52.3	44.4
	Socializer	6.7	28.1	25.0	28.4
	Achiever	13.3	10.5	11.4	7.4
Best player profile for learning	Killer	13.3	21.1	15.9	24.7
	Explorer	40.0	40.4	61.4	55.6
	Socializer	40.0	31.6	15.9	14.8
	Achiever	6.7	7.0	6.8	4.9

IV. DISCUSSION

Most of the participating science professors identify with the Explorer player profile. The proportion of Explorers is double the proportion of the second most frequent player profile, which is the Socializer profile (Table I). Almost three quarters of the participants identify with Explorers or Socializers, i.e., with the least competitive player profiles. Likewise, the choice of the Explorer player profile as the most favorable for learning exceeds 50% of the participants and exceeds the proportion of those who identify themselves as Explorers (Table I). These results are consistent with the player profiles description of engineering professors [43]. According to the results shown of Vergara *et al.* [43] for engineering professors, the Explorer player profile is the most frequent and the most suitable for learning. However, the differences with the rest of the player profiles are smaller than in the case of science professors studied here.

The results show that there is a strong gap between the player profiles of the science professors and the player profiles of the students, who are mostly Achievers [36–38] in the absence of studies that analyze the specific player profiles of the science students.

In the opinion of the authors, the greater presence of Explorers among science professors could be explained, on the one hand, by the characteristics of the scientific-technical areas of knowledge and, on the other, by the age of the participants. Indeed, the inquiry, search, and experimentation skills typical of scientific-technical areas may lead professors in these areas to identify with the Explorer player profile. This is consistent with the fact that engineering professors also mostly identify with the Explorer player profile [43]. However, the general evolution of character and personality towards less active traits with increasing age could also affect the determination of the player profile. This would explain the lack of agreement with the player profiles of the students [36–38]. However, all this should be corroborated in subsequent studies.

Significant gaps have been identified between the player profiles of science professors and the player profiles more suitable for learning (Table II). Around half of the Killers and Socializers and around 30% of the Achievers identify the Explorer player profile as the most suitable for learning (Table II). This is in line with the third person POV perspective [42], which suggests the need to harmonize the player profiles of students and professors in the best search for the didactic effectiveness of the gamified strategy.

The results prove that the gender of the participating science professors influences their player profile and the choice of the player profile considered best for learning. Specifically, males identify with and opt in greater proportion for the most active and competitive player profiles than females (Table III). This result shows that, among science professors, there is a gender gap in terms of player profiles that does not exist among engineering professors [43]. Likewise, the result is novel with respect to what the literature supports regarding the perception of professors, in general, about educational gamification, who do not identify gender gaps in this regard [44]. However, the present study does not identify significant differences in the player profile choices based on the age of the participating professors. This agrees with some previous studies [44], but contradicts the analogous results obtained for engineering professors [43]. Specifically, increasing the age of engineering professors has the effect of decreasing the choice of the most active and competitive profiles (Achiever and Killer) and increasing those that are less interactive and competitive (Explorer and Socializer) [43]. Here, it has been shown that this influence of the age does not occur among science professors (Table IV and Table V), which is a novel and original contribution of the present work.

Finally, it has also been proved that the experience in the use of gamification strategies influences both the self-concept of the player profile of science professors and their choice of the best player profile for learning. This means that practical experience provides a more realistic view of what one's own dominant skills are, and which skills are more suitable to learning according to the specific discipline, what conditions the player profile. This observation is in line with the preceding literature, which suggests that faculty training in educational gamification should incorporate practical experience [43]. In the specific case of science education, experience in the use of gamification reinforces the Explorer player profile, in the sense that this player profile is more frequent among those who have experience than among those who do not (Table VI). This higher frequency of Explorers among experienced professors is higher among males than among females (Table VII). It is also more frequently chosen as the best profile for learning among those who have previous experience than among those who do not (Table VI). This contribution is novel in the specialized literature, because no studies have been found, as far as it has been possible to explore, that address the influence that experience in the use of gamification has on professors' perceptions.

Consequently, it can be assumed that the player profiles of science professors are distributed approximately like those of engineering professors, studied by Vergara *et al.* [43]. Specifically, most Explorers and a minority of Achievers. However, among engineering professors there are statistically wider gender and age gaps than among science professors. Female engineering professors choose the Explorer profile more than males, while males choose more active profiles (Killers and Achievers). The same gap tends to occur among science professors, although to a lesser extent. Likewise, younger engineering professors are also more likely than older professors to opt for the more active player profiles. These differences do not occur among science professors.

As can be noticed in Fig. 5, the Explorer player profile is the most frequent among participating science professors. However, the specialized literature attributes to higher education students the Achiever player profile [36–38]. The most common player profile is Explorer among both male and female science professors. But the proportions of the most competitive and active player profiles—Achievers and Killers—are higher among male science professors than among females, with a difference of around 7% points (Fig. 5). Finally, it seems that having experience in the field of gamification influences the type of player profile selected by science professors, increasing the Achievers and Explorer profiles to the detriment of the Killer and Socializer percentages (Fig. 5).

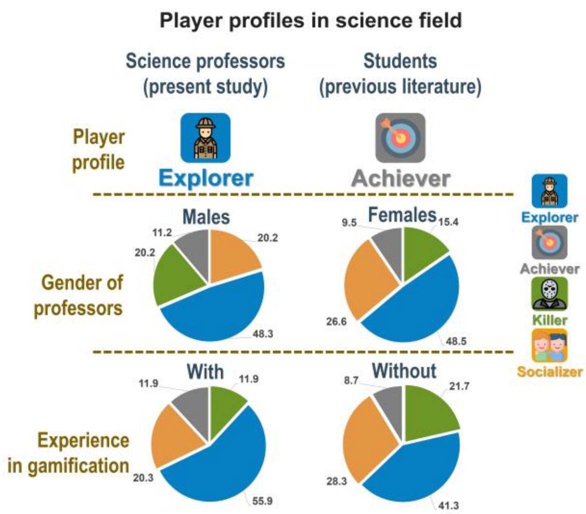

Fig. 5. Main results obtained on the player profiles of science professors.

It is worth mentioning certain limitations of the study and lines of future research. Specifically, it would be interesting to conduct research analogous to that presented here, but carried out on a sample of science professors that is distributed homogeneously by gender. This would avoid the possible bias that could be caused by the lack of homogeneity in the distribution and thus contrast the results obtained. It is also suggested that qualitative research should be carried out to identify the reasons underlying the choices of player profile made by science professors, to further deepen the results described here. In addition, a comparative analysis of the player profiles of professors from different areas of knowledge should be carried out. This would allow to understand if the area of knowledge significantly influences the professors' player profile and the choice of the most suitable player profile for the learning of the specific subject in each case. This paper has laid the foundations for an analysis in this sense among professors of scientific and technical areas. Finally, it would be useful to address, through a comparative analysis carried out in different geographical areas, the influence that geographical location could have on the choices of player profile made by the professors.

V. Conclusion

There is a gap between the player profiles of university students (mostly Achiever) and that of science professors (among whom almost 50% are Explorers). There is also a gap between the player profile of science professors and the choice of the most suitable player profile for learning. Specifically, around 50% of Killers and Socializers and around 30% of Achievers believe that the best player profile for science learning is the Explorer profile, even if it does not coincide with their own player profile. The gender of science professors influences their choices of player profile. In general, males identify more frequently with the more interactive and competitive player profiles (Killer and Achiever) than females, and they also consider these player profiles to be more suitable for learning. In contrast, the age of the science professors does not significantly influence the choice of player profile. Finally, experience in the use of gamification strategies also influences the player profile. Professors with previous experience identify more with the Explorer player profile than those without such experience. Also, the proportion of those professors who consider the Explorer profile as the best for learning is also higher among them than among those who have no previous experience in gamification.

The results obtained imply that the experience of science professors in gamification can really condition the self-concept about the player profile and, therefore, the perspective that they will project in their design of gamified situations. Science professors should also be trained in the development of techno-pedagogical skills linked to the design of gamified strategies. Therefore, it is recommended that universities implement specific training on the development of gamification strategies in science lectures. These trainings should be aimed at adapting the player profiles to the personality of the students and to the specific learning objectives.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, D.V. and A.A.-S.; Methodology, A.A.-S. and P.F.-A.; Data curation, A.A.-S.; Data analysis P.F.-A. and D.V.-R.; Writing the paper, D.V., A.A.-S., and P.F.-A.; Supervision, D.V., A.A.-S., and P.F.-A. All authors have approved the final version.

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