Playing it right: Empirical validation of the Gamertype scale for game-based learning in higher education

Jugar correctamente: validación empírica de la escala Gamertype para el aprendizaje basado en juegos en la educación superior

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Abstract:

The growing interest in applying gamified designs in higher education is challenged by mixed results in terms of student acceptance. Different players are attracted to games for different reasons and game design elements, and a better understanding of how each learner will connect to different game mechanics provides valuable input for game design and evaluation. In this paper, we present and validate a scale to measure the affinity of each player with different game elements. First, a theoretical review was carried out on three profile classifications and six motivational theoretical models, proposing a taxonomy for twelve player profiles based on three axes: relational, competence and motivational. Then, a pilot test was carried out with 54 subjects, analysing content and comprehension validity through the judgment of six experts and construct validity through an exploratory factorial analysis. Subsequently, with a sample of 1010 subjects, a confirmatory factor analysis was performed. The scale was made up of 30 items, with a Cronbach's alpha of 0.822; three main components were obtained: dominators, interactors and trackers. The results show the validity of the scale, with high levels of confidence. It provides an understanding of the player's profile in a playful context, their motivational orientation and their affinity with the specific game design. This can be used to improve the design of gamified experiences in higher education.

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Keywords: scale, gamification, profile, player, validation, motivation, game-based learning, games, design, education, confirmatory analysis, exploratory analysis, factor analysis.

Resumen:

El interés creciente por la aplicación de diseños gamificados en la educación superior se ve cuestionado por un nivel de aceptación desigual de los alumnos. Cada jugador siente atracción por el juego por distintos motivos y por ítems de diseño diferentes. Por ello, comprender mejor la conexión de cada alumno con las distintas mecánicas del juego resulta de gran valor para su diseño y evaluación. En este artículo, se presenta y valida una escala para medir la afinidad de cada jugador con los distintos ítems del juego. En primer lugar, se llevó a cabo una revisión teórica de tres clasificaciones de perfiles y seis modelos motivacionales teóricos. Como resultado, se propuso una taxonomía de doce perfiles de jugador basada en tres ejes: relacional, competencial y motivacional. A continuación, se realizó una prueba piloto con 54 sujetos en la que se analizó, por un lado, la validez del contenido y la comprensión mediante la valoración de seis expertos y, por otro, la validez de los constructos mediante un análisis factorial exploratorio. Posteriormente, se efectuó un análisis factorial confirmatorio con una muestra de 1010 sujetos. La escala se compuso de 30 ítems, con un alfa de Cronbach de 0.822; se obtuvieron tres componentes principales: dominadores, interactuadores y rastreadores. Los resultados muestran la validez de la escala, con altos niveles de confianza. Permite conocer el perfil del jugador en un contexto lúdico, su orientación motivacional y su afinidad con el diseño de juego específico. Esta información puede utilizarse para mejorar el diseño de experiencias gamificadas en la educación superior.

Palabras clave: escala, gamificación, perfil, jugador, validación, motivación, aprendizaje basado en juegos, juegos, diseño, educación, análisis confirmatorio, análisis exploratorio, análisis factorial.

1. Introduction

Different players are drawn to different reasons and game elements, and a better understanding of how each learner will connect with different game mechanics is a valuable input for game design and evaluation. As indicated in a review by Prieto (2022), studies have combined gamification with other alternatives such as game-based learning (GBL). On the one hand, gamification is the practice of using game design elements, game mechanics and game thinking in non-game activities to motivate participants. On the other hand, GBL is being used to encourage students to participate in learning while playing and to make the leaning process more interesting by adding an element of fun (Al-Azawi et al., 2016).

GBL and gamified educational proposals have been widely studied and are capable of modifying human behaviour (Krath et al., 2021).

In a systematic review, Johnson et al. (2016) determined that 59% of the gamified

experiences analysed had positive effects on behaviours related to health and well-being, while 41% of the effects were mixed. However, these data suggest that we cannot always predict the impact of these experiences on all players, with different students reacting differently to the same games. This problem is relevant, given that these learning experiences are typically costly to design and implement. As a result, a number of questions emerge: Are we wasting efforts on GBL experiences that are not well accepted by students? Why are some players deeply affected by these experiences while others do not feel the same? Can we design games that are more widely accepted by all types of players? How can we help students feel more fulfilled and comfortable with their own decisions in a gaming environment?

For these reasons, this study aims to validate a scale that allows gamified proposals to be adapted the characteristics of the players. It also gathers the experiences of different studies that have identified or categorised different player profiles or theorised about different profiles based on various personality models and player types (Bartle, 1996; Ferro et al., 2013; Fullerton, 2008; Hamari & Tuunanen, 2014; Marczewski, 2015; Nacke et al., 2013; Schuurman et al., 2008; Vahlo et al., 2017; Yee, 2015). In this section, we delve deeper into these existing studies and propose a specific instrument to measure and catalogue student/player profiles. Then, we conduct a two-stage experiment to validate the instrument, conducting a first pilot study to assess and improve the instrument and then validating the results in a wider study.

1.1. Theoretical framework

In particular, the twelve dimensions (grouped into six player motivation profile)s by Yee (2015) are empirically supported, although they lack a standardised assessment tool. The seven BrainHex archetypes, which denote different player motivations (Nacke et al., 2013), obtained low reliability. In turn, Hamari & Tuunanen (2014) suggested five dimensions related to game motivations, although their use in a non-game field, such as the educational field, is limited. In another relevant approach, Ferro et al. (2013) determined five categories of players according to the prioritised elements of the game (dominant, objectivist, inquisitive, creative and humanistic), although their work was theoretical and lacks empirical validation. The studies by Vahlo et al. (2017) and Schuurman et al. (2008) categorised the different motivations of video-game players by conducting a pilot study, while Fullerton (2008) classified players based on the satisfaction of the participants.

Most of these studies were not based on experimental data and were aimed exclusively at categorising video-game players. Among all of them, those considered as references are the Bartle test (Bartle, 1996) and the Tondello test (Tondello et al., 2019) based on the work of Marczewski (2015).

On the one hand, Bartle's taxonomy (1996) is based on character theory, establishing a classification of four video-game players based on two axes: on the relationship axis, whether players prefer to relate to other players (socialisers and killers) or to the game world (explorers and achievers), and, on the competition axis, whether they

prefer action (killers and winners) or interaction (socialisers and explorers). The new model proposed by Bartle divides the four original types of players according to whether they are of the implicit type (they act without thinking) or the explicit type (they act with prior planning). This division gives rise to eight types of players (Bartle, 2005): socialisers ("explicit networker" and "implicit friend"), assassins ("explicit politician" and "implicit griefer"), winners ("explicit planner" and "implicit opportunist") and explorers ("explicit scientist" and "implicit hacker"). Bartle's taxonomy is very orientated towards video games, so it is not appropriate to use this model in an educational environment. However, the types of players identified in this model can be adapted and found in environments other than video games. Following Bartle (2005), the four profiles emerging from the orientation of their axes are considered as the suits of a standard deck of cards. Interaction with the game world consists of finding out everything that is possible about its dynamics (the explorers would be like spades, digging for information); action towards the world consists of finding out everything you can about its mechanics (the winners would be like diamonds, always looking for treasure); interaction with other players prioritises conversation contexts and communication facilities (socialisers would be hearts, empathising with other players); and action towards other players prioritises manipulating, annoying and confronting others or, on rare occasions, helping them (the assassins would be clubs, they hit others with them for a purpose).

On the other hand, Marczewski's (2015) model is much more orientated towards gamification systems, establishing a somewhat different classification based on six types of players: philanthropists, socialisers, free spirits, achievers, gamers and disruptors. This ranking is more related to the ultimate goal of each profile rather than how they relate to other players or the game. Tondello et al. (2019) developed and validated a standard scale of 24 items to qualify an individual according to each of the six types of users proposed by Marczewski. They have continued their research with the aim of improving some of the psychometric problems identified in the profiles.

1.2. Designing the Gamertype scale

Based on these experiences, we aim to construct a specific scale to classify students according to their gaming preferences and playing styles. As the validated scale is focused on an educational environment, both the students' own motivations and the type of player they most resemble have been taken into account for the proper design and interpretation of the scale.

To create the profiles, we combined the classification of six profiles by Tondello et al. (2019) with Bartle's taxonomy (1996), composed of four profiles based on their relationship and competence axes. Additionally, a third motivational axis has been added to those proposed by Bartle: intrinsic motivation with an enjoyable goal of self-realisation versus extrinsic motivation with a task-orientated goal of obtaining rewards, following the postulates of Ryan and Deci (2000).

A model is presented with twelve profiles (named from profile A to profile L). These profiles arise from three axes

(relational, competence and motivational) and from the three main components to emerge from the exploratory analysis carried out to validate the scale in this study: dominators, trackers and interactors (Figure 1). Self-determination theory (SDT) (Deci & Ryan, 1985) highlights the importance of integrating 3 human psychological needs for a task to be intrinsically enjoyable: competence (dominating component), autonomy (tracking component) and relationship (interacting component). However, each of the main components focuses on one of the three psychological needs, stressing the importance of having self-motivation, obtaining a balanced score between the three components for the adequate development and mental health of the person, as indicated by Ryan et al. (2016).

The three main components seen in Figure 1 have been related to the suits and figures of Spanish playing cards. The dominators are kings (anxious to achieve their goals and have an impact on others), the interactors are jacks (they prefer group-work with fairness and cooperation, using the club to give a warning to their teammates) and the trackers are knights (eager to explore, get rewards and have an impact on the elaborate gamified system, with the priority of collecting coins and cups).

The aim of this study is to validate a scale that analyses the player's profile in a GBL context in higher education. Once the taxonomy has been specified, the essential terms for the measurement of results are proposed in the methodology.

FIGURE 1. Gamertype taxonomy.

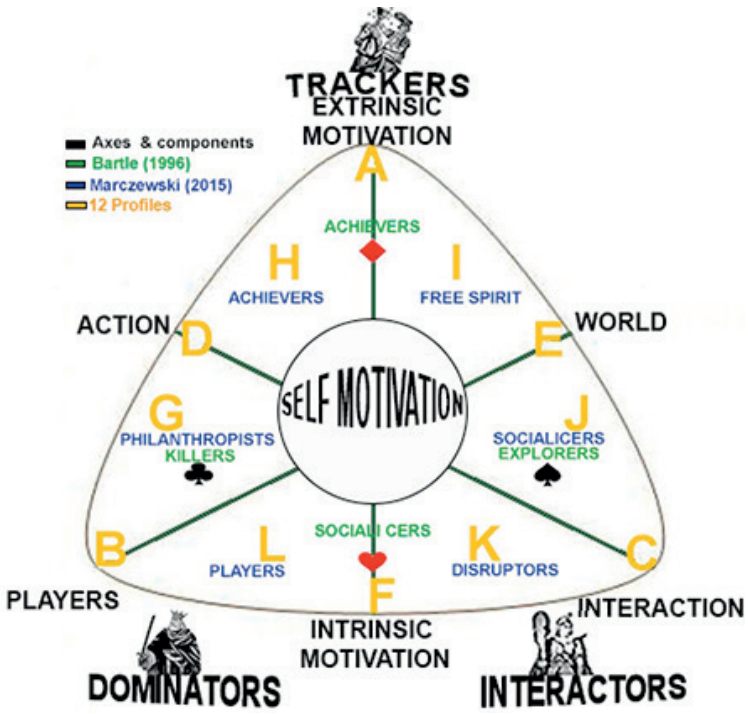


FIGURE 2. Characteristics of the three main components according to theoretical motivational models and empirical theories on types of players.

2. Methodology

This research project is based on a description of the construction and validation process of a scale developed ad hoc to understand different player profiles in a gamified context. The aim is to analyse the construct validity and examine the reliability of the scale. It is a methodological research project based on the survey technique to implement the validated scale (Espinoza & Toscano, 2015).

Firstly, the existing literature on taxonomies and classification models for player profiles was reviewed. Secondly, a bank of possible questions formulated in 39 elements classified in 3 constructs was created, resulting in an initial version that provided an understanding of different player profiles in a game context.

Then, the initial 39-item scale was discussed with a group of six social science experts. Once the degree of adequacy and relevance of each item had been analysed, the items that best analysed the contents in each of the constructs were selected. Any items that three or more experts raised doubts about in relation to the design of the scale were eliminated, resulting in 33 items.

This 33-item scale was used in a pilot test with 54 subjects to analyse the validity of comprehension, eliminating items after analysing the high response frequency, resulting in a more refined version of the scale made up of 30 items.

The construct validity of this scale was analysed through an exploratory factor analysis (EFA) on the pilot sample. This was then tested more widely, performing a confirmatory factor analysis (CFA) with a sample of 1010 subjects, giving rise to the final version of the scale. This final version consisted of 30 items, with all the items related to the total score of the test.

2.1. Participants

The expert consultation phase was performed with six experts from the field of social sciences. They all held the title of doctor and had a professional background of more than seven years on average, as well as an extensive knowledge about the scientific method. Reputation and availability were also taken into account. They were emailed a dossier explaining each of the constructs to be evaluated, together with a cover letter, requesting the degree of formulation, adequacy and relevance of each item. The items that best analysed the contents of each construct were selected, eliminating those that the experts deemed unsuitable.

For the pilot test, a sample of 54 Spanish postgraduate students on a master's degree in Educational Technology and Digital Competences was form through non-probabilistic sampling. This was an intentional and convenience-based sampling due to accessibility to the sample. The second sample was composed of 1010 Spanish subjects (94.6% men and 5.4% women), 10.8% at 20-25 years old, 27.4% at 26-30 years old, 31.8% at 31-35 years old, 16.4% at 36-40 years old and 13.6% over 40 years old. For the second sample, non-probabilistic sampling was used in the form of a snowball, promoting the form on social networks and video-games forums. The respondents agreed to participate in the scale online through the Google Forms platform, using a virtual sample on social networks and in Spanish video-game forums, under the inclusion criterion that they were university students. The participants were informed of the anonymity of their participation and that in no case would any of the collected data be transferred or provided to third parties or companies, being protected according to current legislation (Organic Law 3/2018) and the Declaration of Helsinki (2013) on research with human beings.

2.2. Measures

The player profile scale, or Gamertype (Appendix 1), has been designed and validated in its original Spanish version. The scale consists of 30 items with a Likert-type scale with answers ranging between 1 ("Totally disagree") and 4 ("Totally agree"). The aim of the scale is to qualify a subject's tendency towards each of the twelve player profiles that emerge from its three main components: dominator (items 5, 7, 9, 10, 12, 15, 18, 21, 24 and 26), tracker (items 2, 3, 8, 13,

16, 17, 19, 20, 22 and 27) and interactor (items 1, 4, 6, 11, 14, 23, 25, 28, 29 and 30, with items 4, 11 and 25 being inverted to control bias in response style). To create a graphic representation of the gamertype, a somatochart has been used and modified, a tool used by nutritionists working in the sports branch of nutrition. The region in which the x and y coordinate point sits denotes a range of different meanings (Martínez-Sanz et al., 2011). To find the point and the corresponding profile, the following equation is used: Axis x = Interactor - Dominator / Axis y = 2 × Tracker - (Interactor + Dominator). Automatic measurement at www.joelprieto.eu.

2.3. Data analysis

For the statistical analysis of the scale's psychometric properties, the SPSS statistical program, version 25.0, and the AMOS program were used, considering statistical analysis with a significance level of $p < 0.05$.

To assess construct validity, an EFA was performed by principal components and varimax orthogonal rotation, using the Kaiser-Meyer-Olkin (KMO) sample adequacy index and the Bartlett method.

Subsequently, a CFA was performed to check if the previous theoretical factorial structure resulting in the EFA was adjusted to the data through hypothesis contrasts. Following the guidelines of Merenda (2007) for instrument validation, a CFA with the maximum likelihood extraction method was used to provide estimates of the parameters that the observed correlation matrix had most likely produced. On the other hand, for the evaluation of the fit of the model, the following indices were used: root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis index (TLI) and the normed fit index (NFI).

3. Results

3.1. Content validity and comprehension

Content validation was carried out by six experts, indicating the degree of precision in the formulation, relevance and suitability of each item in terms of its definition and wording (1 = "Not at all suitable/relevant"; 5 = "Totally suitable/relevant"). Once the feedback from the experts was received, certain items in the 39-item Q-initial were amended or removed. Assuming that the three variables (formulation, suitability and relevance) had an equal weighting in the validation of the content of the scale, the assessments generated the following measures of central tendency: x = 4.6, that is, between quite suitable and relevant (4) and totally suitable and relevant (5); with $S(x)$ = 0.5452, Me = 4 (fairly suitable and relevant) and Md = 4 (fairly suitable and relevant). It is evident that at least 92% of the assessments were in the categories of quite and totally suitable and relevant. On the other hand, at least 50% (f = 3) of them suggested the removal of six items and amendment of four items in the initial version of the scale. In terms of the validity of comprehension, a pilot study was carried out in

which the 54 subjects' degree of understanding was assessed. This resulted in the decision to remove items 9, 27 and 32 because they presented the same response in more than 90% of the answers (high response rate).

Regarding the validity of comprehension, in the pilot study, the initial scale consisting of 33 items was presented to the 54 subjects to assess their degree of understanding. Subsequently, the pre-scale consisting of 30 items (removing the three items from the initial scale) was presented to the 1010 participants. A Cronbach's alpha coefficient of 0.822 was obtained for the entire 30-item scale, assuming unidimensionality, noting that all the items were strongly related to the total test score (see Table 1).

TABLE 1. Total test score and its item/test correlation with the 30 items of the final scale.

Item	Scale mean if removed	Scale variance if removed	Total item correlation corrected	Cronbach's alpha if removed
1	77.0743	103.026	.328	.817
2	77.1782	103.175	.360	.816
3	76.9931	112.582	-.197	.837
4	77.7455	110.733	-.114	.831
5	77.1673	100.839	.496	.811
6	77.0802	100.716	.501	.811
7	76.9693	100.613	.397	.814
8	76.9941	104.254	.281	.818
9	77.8693	97.571	.556	.807
10	77.1782	97.138	.598	.806
11	77.9723	108.308	.026	.827
12	78.3079	104.106	.273	.819
13	77.2317	102.519	.331	.817
14	77.3505	104.117	.255	.820
15	77.6990	98.466	.528	.809
16	76.9703	103.355	.364	.816
17	76.9347	101.334	.463	.812

18	78.2178	105.045	.185	.822
19	76.7327	105.050	.241	.820
20	76.7465	103.018	.409	.815
21	77.6040	100.499	.450	.812
22	76.7168	107.057	.131	.823
23	77.5673	101.144	.455	.812
24	77.9842	97.375	.600	.806
25	77.4139	112.604	-.215	.835
26	78.2020	101.927	.346	.816
27	77.5040	98.151	.514	.809
28	77.1139	99.669	.535	.809
29	77.0317	99.714	.494	.810
30	76.7941	103.301	.351	.816

On the one hand, item/test correlations were established for each dimension, with all items having a Cronbach's alpha coefficient of over 0.700, as in the test, in which unidimensionality was assumed. A Cronbach's alpha of 0.731 was obtained for the *dominator* (D) component, 0.714 for the *tracker* (T) component, and 0.730 for the *interactor* (I) component. On the other hand, the method of the two halves was applied (first 15 items + last 15 items), obtaining appropriate scores: a value of 0.716 in the first and a value of 0.723 in the second, with a Spearman-Brown coefficient of 0.854.

3.2. Construct validity

First, an EFA was performed using varimax orthogonal rotation principal component extraction. The Kaiser-Meyer-Oldin (KMO) sample adequacy index reached a value of 0.863 and the Bartlett sphericity test was 12302.118 (df = 435, p = 0.000), which indicates the adequacy of the data. The Kolmogorov-Smirnov normality test was performed, obtaining adequate values in all cases (p >0.05). On the other hand, following the abscissa axis of the sedimentation graph and taking into account the drop contrast criterion, two models were selected, a three-factor model and another twelve-factor model, since the rest of the variance factors tend to stabilise. Likewise, using Kaiser's rule, the eigenvalues greater than 1 also turned out to be twelve. Once the main components have been analysed, after the varimax rotation, including the 30 items that make up the scale, the convergence in three factors explained 56.26% of the variance, and the convergence in 12 factors explained 74.59% of the variance, as seen in Table 2.

TABLE 2. Total explained variance of the scale and goodness-of-fit test for both models.

Factors	Initial eigenvalues			Sums of the squared loadings of the rotation		
	Total	% variance	% variance acummulated	Total	% variance	% variance acummulated
3 factor model						
1	6.784	22.615	22.615	5.164	17.213	17.213
2	3.648	20.158	40.773	4.985	16.616	39.829
3	2.849	13.496	56.269	3.132	10.441	56.269
12 factor model						
1	6.784	22.615	22.615	4.792	15.974	15.974
2	3.648	12.158	34.773	4.188	13.960	29.934
3	2.849	9.496	44.269	1.962	6.540	36.474
4	1.766	5.885	50.155	1.786	5.953	42.427
5	1.155	3.852	54.006	1.622	5.407	47.834
6	1.082	3.606	57.613	1.458	4.861	52.695
7	1.029	3.428	61.041	1.261	4.202	56.897
8	1.001	3.336	64.377	1.190	3.968	60.865
9	.817	2.725	67.102	1.134	3.780	64.645
10	.804	2.682	69.784	1.095	3.651	68.297
11	.759	2.529	72.313	1.057	3.523	71.819
12	.684	2.280	74.593	1.002	2.773	74.593

Following the variance percentages that explain each factor, in the three-factor model, the first factor explains 22.61% of the variance in the collected information, the second factor 20.15%, and the third factor 13.49%. The analysis detects the three and twelve latent factors that were indicated by the literature and that explain 56.26% and 74.59% of the common variance, respectively, describing the goodness of fit of these structures of three and twelve factors calculated through two hypothesis tests with an χ^2 distribution. On the other hand, for the interpretation of the factors, we started from the initial matrix of rotated components. As seen in Table 2, these components determined different factor saturations for the selection of the items included in each of the three- and twelve-factor models. To interpret the extracted factors, Table 3 presents the rotated component matrix with the varimax rotation method with Kaiser normalisation, with the factorial saturations that express the magnitude of the correlation between the item and the factors, ordered by size. Small coefficients, with a low absolute value of 0.25, have been supressed.

TABLE 3. Variables of each factor in the matrix of three and twelve rotated components.

Matrix of 3 componets					Matrix of 12 components												
Items	**1**	**2**	**3**	**C**	**Items**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**C**
GT23	.773			62%	GT23	.688									.698			74%
GT28	.758	.274		66%	GT29	.679									.682			73%
GT1	.752			58%	GT28	.772	.247	.201										74%
GT25	-.731		.275	61%	GT30	.753												75%
GT6	.729	.208		48%	GT6	.710					.301							74%
GT29	.718			56%	GT1	.512								.518				70%
GT14	.694			56%	GT25	-.509							.322		.289			73%
GT30	.692			59%	GT14	.299										.501		74%
GT5	.435	.437		52%	GT24		.828											78%
GT4	-.402			42%	GT15		.792											72%
GT2	.353		.347	42%	GT9		.776											69%
GT24		.774		64%	GT27		.630					634						70%
GT9		.761		60%	GT26		.392			-.314							.492	74%
GT26		.742		57%	GT10	.293	.388			-.259	.425							69%
GT10		.700		61%	GT13			.830										78%
GT27		.579	.679	51%	GT17			.719								.352		73%
GT15		.578		55%	GT20			.501				.459		.567				71%
GT7		.554		45%	GT18				.742	-.331								75%
GT21		.538		54%	GT11				.739	.252								73%
GT3		-.536	.542	51%	GT12		.292		.705									76%
GT12		.411		40%	GT3		-.296			.740								71%
GT18		.392		41%	GT19			.345		.724					.285			70%
GT17			.708	55%	GT7		.304			-	.763							82%

GT20			.674	59%	GT5	.323	.347				.659						81%
GT22			.623	55%	GT8							.908					88%
GT19			.619	53%	GT22					.271			.811				82%
GT13			.592	45%	GT2									.862			87%
GT16		.342	.481	49%	GT4										.883		88%
GT8			.410	42%	GT16											.844	89%
GT11	-.349		.342	41%	GT21		.552									.594	79%

Note: The items of the final questionnaire apper order by correlation size between item/factor. C=communalities (principal components analysis).

Regarding the communalities, the twelve-factor model can fully reproduce the variability of all the items in appropriate proportions in each case, with an average of 76%. On the other hand, in the three-factor model, the average is 53%. Considering the similarity of the items that correlate with each factor, Table 5 shows that the items with the highest correlation with factor 1 (interactor) are, in descending order, items 23, 28, 1, 25, 6, 29 , 14, 30, 4 and 11, with a factor loading between 0.402 and 0.773. The items with the highest correlation with factor 2 (dominator) are items 24, 9, 26, 10, 15, 7, 21, 5, 12 and 18, with a factor loading between 0.411 and 0.774. And the items with the highest correlation with factor 3 (tracker) are 17, 20, 22, 19, 13, 27, 3, 16, 8 and 2, with a factor loading between 0.347 and 0.708. As for the saturations of the 12-factor model, they are between 0.100 and 0.908. Therefore, it is interpreted that the items that have been extracted for each factor have acceptable saturations and that both the three-factor model and the twelve-factor model can be constituted as three and twelve one-dimensional scales that represent more than 74% of the variance. The denomination of the resulting twelve factors has been determined based on their constituting elements. These twelve factors are:

- Factor 1 (items 6, 28 and 30): E. The tracker and interactor components are similar, and the dominator component is smaller. Orientated towards the world of the game. This group has been called *seekers*. They are thrill seekers trying new experiences, they love the aesthetics and narrative of both the system and the mechanics, dynamics and aesthetics (MDA) approach and they enjoy trying new things.
- Factor 2 (items 9, 15 and 24): B. The dominator component is dominant, while the interactor and tracker components are similar. Player orientated. This group has been called *raptors*. They want their actions to have an

impact on the other players, getting very involved in achieving goals and feeling frustrated if they don't receive social recognition.

- Factor 3 (items 13 and 17): H. The tracker component is dominant, and the dominator component is greater than the interactor component. Orientated towards relating to action and extrinsic motivation. This group has been called *achievers*, as in Marczewski and Bartle's theory. They are mastery-driven, independent, competitive and success-focused. They seek to learn new things and improve through self-improvement challenges, climbing and unlocking levels or gaining status within the community or team.

- Factor 4 (items 11, 12 and 18): G. The dominator component is dominant, and the tracker component is greater than the interactor component. Orientated towards interaction with other players and action. This group has been called *vehement*, following Marczewski's classification. They are motivated by purpose and meaning.

- Factor 5 (items 3 and 19): D. The tracker and dominator components are similar, and the interactor component is smaller. Action orientated. This group has been called *tenacious*. They look for novelty and originality both in the system and in the MDA approach, getting very involved in missions, quests and challenges. They may feel too self-absorbed with use of the MDA approach.

- Factor 6 (items 5, 7 and 10): F. The dominator and interactor components are similar, and the tracker component is smaller. Orientated towards interacting with other players and interaction. This group has been called *explorers*, they seek to interact with other players to share ideas and/or experiences, enjoying teamwork and interacting with other players and not so much the game itself.

- Factor 7 (items 8 and 27): A. The tracker component is dominant, while the interactor and dominator components are similar. Orientated towards relating to the world of the game and the action. This group has been called *victors*. They want their actions in the game world to have an impact, getting very involved in the MDA approach and feeling disappointed if their efforts are ignored.

- Factor 8 (items 22 and 25): I: the tracker component is dominant, and the interactor component is greater than the dominator component. Orientated towards relating to the world and orientated towards extrinsic motivation. This group has been called *conquerors* and is also referred to as *free spirit* by Marczewski. They are motivated by autonomy and have a preference for creating and exploring.

- Factor 9 (items 1, 2 and 20): J. The interactor component is dominant, and the tracker component is greater than the dominator component. Orientated towards relating to the game world and

interaction. This group has been called *socialisers*, following Marczewski's classification. They are motivated by relationships, improvement and continuous learning, preferring to interact with others and create social connections.

- Factor 10 (items 4, 23 and 29): C. The interactor component is dominant, while the dominator and tracker components are similar. Interaction orientated. This group has been called *colleagues*. They seek to interact and have fun with other players, getting involved in social networks.

- Factor 11 (items 14 and 16): K. The interactor component is dominant, and the dominator component is greater than the tracker component. Orientated towards relating to interaction and orientated towards intrinsic motivation. This group has been called *disruptors*, following Marczewski's classification. They are motivated by change and generally want to disrupt the game system, either directly or through other users to force positive or negative change.

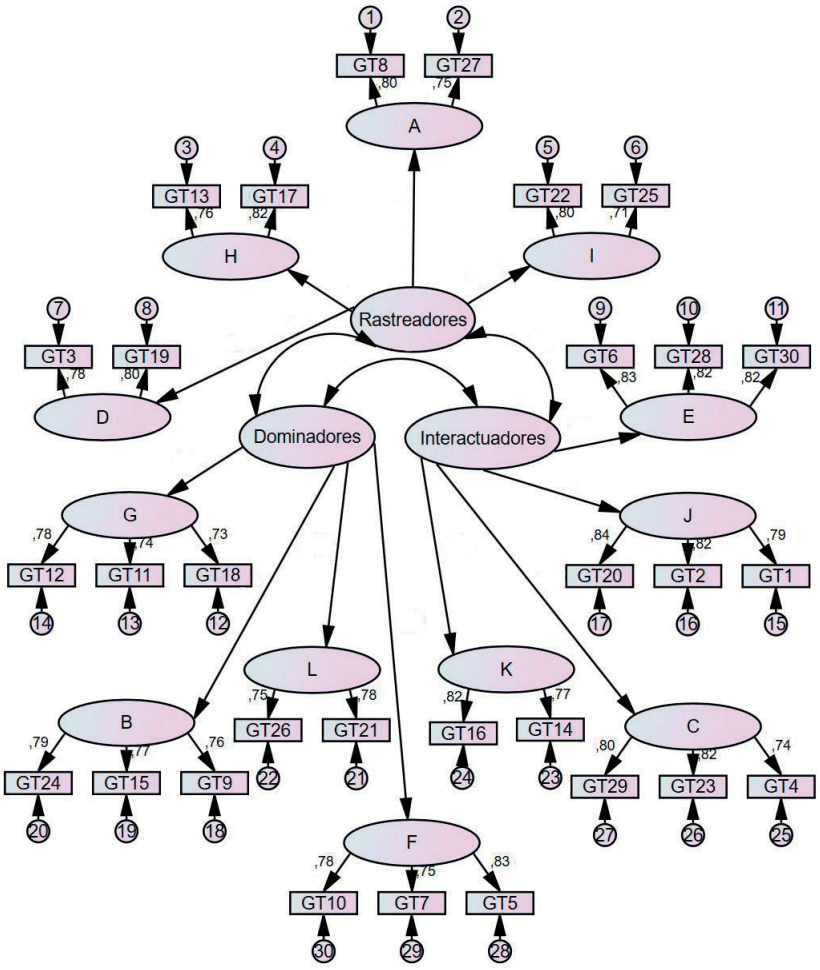
- Factor 12 (items 21 and 26): L. The dominator component is dominant, and the interactor component is greater than the tracker component. Orientated towards relating to other players and orientated towards intrinsic motivation. This group has been called *players*, following Marczewski's classification. They are not motivated by rewards, and they are motivated by making themselves known.

Following the EFA, a CFA was carried out with a sample of 1010 subjects in order to understand the resulting factorial structure in the EFA and to check if said previous theoretical structure fitted the data through hypothesis contrasts. It was verified that the matrix was not affected by the common variance bias through Harman's single factor test. However, two models were tested to check the factorial validity of the scale. In the first model, the factorial structure of the model with three factors was analysed, introducing the 30 items on the scale as reagents (10 items in each factor), showing factorial structure regression weights of between 0.36 and 0.68. In the second model, the factorial structure of a model with three main components was analysed, with twelve latent factors, grouping the 30 items into twelve second-order factors, with regression weights ranging between 0.30 and 0.91.

After the results of the maximum likelihood method and the eigenvalue criterion >1, the significance associated with χ^2 (218.273) being 0 for the three-factor model and χ^2 (222.969) for the twelve-factor model, the RMSEA was used to assess the fit of the model. The model is thought to have a good fit if the RMSEA is less than 0.06 (Hu & Bentler, 1999), being 0.043 for the twelve-factor model and 0.057 for the three-factor model. On the other hand, χ^2/gl was used, considering values of less than 5 as acceptable, with values of 0 in both models. The CFI, TLI and NFI indices considered by Hu and Bentler (1999), with acceptable values being greater than 0.90, were 0.75, 0.83 and 0.92 in the three-factor

model, and 0.97, 0.95 and 0.92 in the twelve-factor model, being considered acceptable. Figure 3 shows the factorial structure of the model with three first-order principal components and twelve second-order latent factors.

FIGURE 3. Factorial structure of the model with twelve latent factors and three main components.



3.3. Convergent validity

To analyse the convergent validity, Table 4 shows that bilateral bivariate correlations were established between the three-factor and twelve-factor models of the Q-final and their items through the Kendall correlation coefficient. The correlation between items/factor was 0.259 and 0.679 in the three-factor model, with an average of 0.569, and between 0.594 and 0.898 in the twelve-factor model, with an average of 0.746.

Table 5 shows the correlations and significance levels between the twelve profiles and between the twelve profiles and the three main components.

TABLE 4. Correlations between the factors of the final scale and its items in both models.

Model	Factors	Items of each factor									
3 factors	Dominator	it5: 0.327	it7: 0.460	it9: 0.643	it10: 0.518	it12: 0.400	it15: 0.565	it18: 0,372	it21: 0,469	it24: 0,679	it26: 0,582
	Tracker	it2: 0.281	it3: -0.103	it8: 0.348	it13: 0.452	it16: 0.405	it17: 0.413	it19: 0,336	it20: 0,347	it22: 0,259	it27: 0,529
	Interactor	it1: 0.476	it4: -0.489	it6: 0.522	it11: 0.568	it14: 0.491	it123: 0.618	it25: -0,407	it28: 0,588	it29: 0,624	it30 0,553
12 factors	A	it8: 0.594		it27: 0.758							
	B	it9: 0.776		it15: 0.712		it24: 0.777					
	C	it4: 0.610		it23: 0.708		it29: 0.710					
	D	it3: 0.787		it19: 0.673							
	E	it6: 0.703		it8: 0.793		it30: 0.721					
	F	it5: 0.659		it7: 0.706		it10: 0.704					
	G	it11: 0.613		it12: 0.639		it18: 0.696					
	H	it13: 0.898		it17: 0.736							
	I	it22: 0.613		it25: 0.769							
	J	it1: 0.663		it2: 0.668		it20: 0.534					
	K	it14: 0.705		it16: 0.560							
	L	it21: 0.753		it26: 0.724							

Note: it (item).

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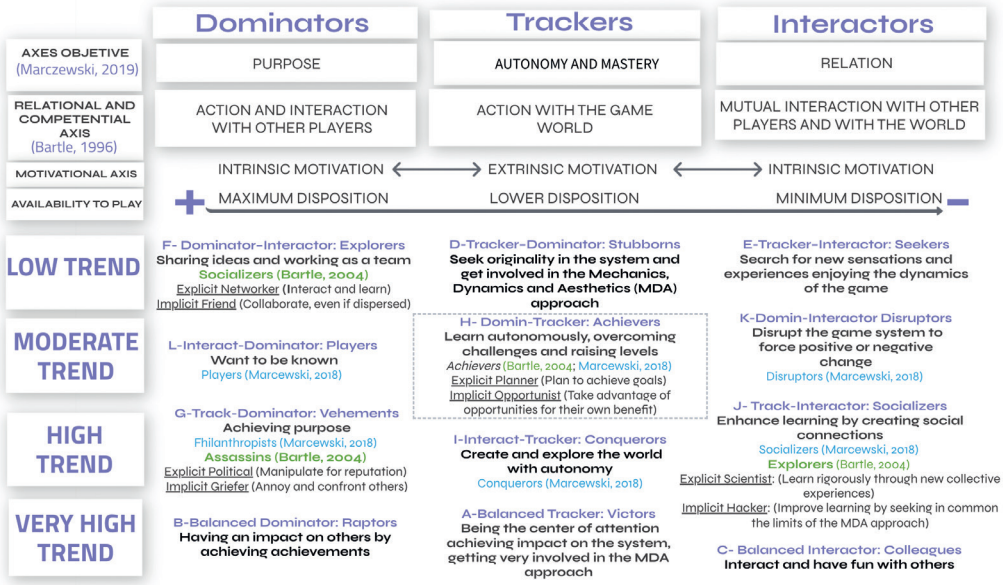
TABLE 5. Correlations between the twelve latent factors with each other and with the three main components.

	E	B	H	G	D	F	A	I	J	C	K	L
E		.229**	.137**	-.014	-.043	.222**	.137**	-.125**	**.390****	**.453****	**.271****	.171**
B	.229**		.154**	**.463****	-.167**	**.482****	.455**	-.121**	.152**	.197**	.188**	**.532****
H	.137**	.154**		.099**	**.183****	.166**	**.520****	**.181****	.179**	.062*	.131**	.110**
G	-.014	**.463****	.099**		-.142**	**.396****	.092**	.094**	.060*	.060*	.048	**.355****
D	-.043	-.167**	**.183****	-.142**		-.168**	**-.471****	**.189****	.035	.000	.032	-.168**
F	.222**	**.482****	.166**	**.396****	-.168**		.376**	-.165**	.226**	.225**	.195**	**.411****
A	.137**	.455**	**.520****	.092**	**-.471****	.376**		**-.457****	.191**	.116**	.145**	.325**
I	-.125**	-.121**	**.181****	.094**	**.189****	-.165**	**-.457****		-.130**	-.180**	-.179**	-.094**
J	**.390****	.152**	.179**	.060*	.035	.226**	.191**	-.130**		**.280****	**.272****	.062*
C	**.453****	.197**	.062*	.060*	.000	.225**	.116**	-.180**	**.280****		**.267****	.135**
K	**.271****	.188**	.131**	.048	.032	.195**	.145**	-.179**	**.272****	**.267****		.094**
L	.171**	**.532****	.110**	**.355****	-.168**	**.411****	.325**	-.094**	.062*	.135**	.094**	
DOM	.258**	**.747****	.126**	**.324****	-.223**	**.538****	.312**	-.124**	.188**	.261**	.182**	**.644****
RAS	.129**	.200**	**.490****	.104**	**.255****	.220**	**.574****	**.242****	.232**	.135**	.211**	.239**
INT	**.677****	.148**	.260**	.073**	.157**	.224**	.118**	-.207**	**.487****	**.546****	**.417****	.101**

Note: *p <.05; **p <.01; DOM = dominators; TRA = trackers; INT = interactors.

Figure 4 shows the theoretical objectives of the twelve profiles, following their classification according to the three main components (dominator, tracker and interactor), associating each of the main components with the four profiles that are most popular. In Figure 4, these twelve profiles are linked to the four profiles devised by Bartle (1996) and the six profiles devised by Marczewski (2015), which are explained in Figure 2, among other profiles and theories related to motivation.

FIGURE 4. Theoretical objectives of the twelve player profiles.



To determine the order of the profiles in each main component, the axes of the model were taken into account, with the lowest scores being those located furthest from the axes. The highest scores were the profiles located closest to the axes, being the profiles with the greatest tendency towards each principal component: B (balanced dominator), A (balanced tracker), and C (balanced interactor).

4. Discussion

The taxonomy presented in this paper is based on both Marczewski's (2016) 6 Hexad profiles model and Bartle's (1996) four profiles and two axes, since they are more suitable for personalising playful systems. In the validated Marczewski scale, there are nine items below .600 that weaken the fit in four of the six scales: free spirit, achiever, player, and disruptor. Although the calculated RMSEA = .069 (90% CI = [.061, .077]) is just above the recommended cut-off for a well-fitting model (.06), 37.5% of the scale items are below .600 and therefore goodness of fit is not confirmed as the threshold in this study is 100% above .700. Starting from the taxonomy created in this study, the main differences between the resulting profiles are highlighted in comparison with Marczewki's Hexad model (2016).

In Marczewski's Hexad model, the profiles H-achievers, I-free spirits and J-socialisers are intrinsically motivated. In the proposed taxonomy, the profiles L-players, K-disruptors and F-explorers would be intrinsically motivated, with the explorers being the most intrinsically motivated with their goals of sharing ideas, working as a team, interacting and learning. They would also coincide, being intrinsically motivated, although to a lesser degree, with the J-socialisers and the G-vehements. On the other hand, following Huta and Waterman (2014), having a purpose facilitates internalisation, motivation and personal satisfaction. In Marczewski's model (2015), the intrinsically motivated *philanthropist* profile is proposed with the purpose of helping others without expecting any reward. The author points out that philanthropists and socialisers are motivated by interactions, although he admits that he is unable to discriminate between these two types of users. In the theoretical background of the present taxonomy, this profile is recognised as *vehement* due to its orientation towards action and towards the players and due to the coincidence of its axes with the profiles proposed by Bartle (1996). The purpose of vehements is not to help but to manipulate in search of reputation or to annoy and confront others, in line with the "explicit politician" profile and the "implicit griefer" profile, respectively, as proposed by Bartle (1996).

In Marczewski's Hexad model (2016), the profiles L-players, K-disruptors and G-philanthropists or vehement are extrinsically motivated. In the present taxonomy, the profiles A-winners, H-winners, and I-free spirit are extrinsically motivated. Following Marczewski (2016), it is agreed that the H-achievers are motivated by achievement and the achievement of goals; it is the H-achievers, not the L-players, who focus on extrinsic rewards. Regarding the disruptors, Marczewski (2016) orientates them towards extrinsic motivation, although, as the author himself indicates, this orientation is indicated by observing said behaviour in online games, not deriving from the SDT model and lacking empirical validity. In the present taxonomy, K-disruptors are orientated towards interaction and intrinsic motivation, with the goal of disrupting the gaming system for fun to force either positive or negative change being considered intrinsic. On the other hand, and in agreement with Marczewski (2015), the I-free spirits are motivated by autonomy and creativity, remaining within the limits of the system without wanting to change it, while the K-disruptors seek to expand beyond the limits of the system. Along with their desire to change the system, the K-disruptors and G-vehements could have cyberbullying or trolling tendencies, hindering the experience of other players with negative attitudes towards a player from the same or a different team.

Naturally, players could cross over from one profile to another, moving between them at different cut-off points depending on their state of mind or strategy in the current game. This highlights that the motivations to interact with game systems are not fix throughout the game. An individual's life and life events vary

over time. When classifying the types of players, it is very important to take into account gaming behaviours, motivation to play and lifestyles, since significant events in the lives of players could also make them fluctuate between different profiles. It is suggested that most players have a main component that they prioritise over the rest: dominator, interactor or tracker, changing only deliberately or subconsciously to allow them to advance through the game. Following Mora et al. (2017), the application of gamification in higher education can be challenging, due to some unwanted effects caused by the lack of proven design methodologies that have been detected. Choosing the most suitable formal process for gamification design and the correct profile has become a key requirement for success.

Determining the profile corresponding to each member of a work team in a gamified context can be quite useful in practice, since the interrelationships that can be established between the different profiles are subtle if a balanced work team is established. However, when the dominance of one of the three main components is a priority in the majority of the subjects in the same team, discrepancies could arise. If the majority have a high score in the tracking component, it will add depth and interest to the spectacular nature of the game world, with their priority being to accumulate rewards if they misdirect their motivation. If the elevated component is the interactor, communication will be prioritised, generating a social network in which the objective of the game can be dissipated. And if the elevated component is the dominator, emphasis would be placed on gaining achievements by social recognition. This could become complex if all the group members were egomaniacs to a certain degree, since this component usually parasitises both the trackers and the interactors to achieve their goals of social recognition.

5. Conclusions

The creation of this taxonomy and the standardised and validated scale to determine the twelve types of players according to the three main components and the three proposed axes is a promising approach with real potential application in the customisation of gamified systems. As in a review by Sezgin (2020), it is recognised that the typologies of players identified in this study may not be extrapolated to all environments or cultural contexts, as in the studies carried out by other authors who have tried to categorise different types of players. For this reason, use of the gamertype (scale of types of players) in samples from different geographical areas is recommended.

Empirical studies have shown that a user's personality traits can predict their level of enjoyment if different mechanics or dynamics, such as leaderboards, rankings, scoring systems, etc., are used or not used in the design of gamified proposals (Jia et al., 2016; Tondello et al., 2016). Having a validated instrument allows instructional designers to gain a better understanding of the nature of a

specific student population. It can also lead the design of gamified experiences towards more effective proposals that resonate better with heterogeneous student populations or that may even be adapted to cater for different profiles. Regarding gender, a study by Zahedi et al. (2021) suggested that gamification is a gender-neutral learning engagement strategy that improves female students' performance as much as male students. Regardless of improved performance, most women did not actively enjoy or were not motivated by the virtual points or leaderboard. As a future line of research, the motivational differences and the profiles of both genders could be observed and analysed.

Additionally, as another future line of research, it is proposed to cross the results of the Gamertype scale with the big five scales (to evaluate the way a person acts and all aspects related to personality: extraversion, cordiality, conscientiousness, emotional instability, neuroticism and openness to experience), MBTI (to assess an individual's personality type using 4 sets of opposite pairs: extrovert/introvert, sensing/intuitive, rational/emotional and qualifying/perceiving) and MSLQ (to assess motivational orientation and use of different learning strategies by students in a given activity). On the other hand, the scales that could be used to determine the motivations of a user belong to a theory known as *self-determination theory* (STD), the most pertinent being the basic psychological need satisfaction scale. This scale provides a general understanding of the basic motivations of a user with respect to the three different needs on which the three main components of the scale are based (competence, autonomy and relationships). Another relevant scale is the intrinsic motivation inventory (IMI), which is used to measure levels of user interest/enjoyment, competence, effort, value/utility while using the gamified system. Lastly, additional validation work on the gamertype scale in other languages would be interesting. Regarding the limitations of the validation of the scale, the intra- or inter-rater reliability was not calculated through the Kappa index, nor was temporal stability analysed.

Regarding the practical applicability of the scale, the scale could have practical applicability in other educational stages following the 3 main profiles, in primary or secondary education. The dominators could be students who seek to excel in subjects, the interactors could be those who enjoy group projects and the trackers could be students motivated by exploration and obtaining educational rewards.

The Gamertype scale could also be used in other populations outside of the educational context, in online games, professional settings, sports competitions or healthcare settings. In online games, dominators can enjoy competitive challenges and lead teams. A design that includes strategic battles or missions that emphasise conquest and achievement might appeal to this group. In turn, interactors would enjoy cooperative games in which they work as a team to achieve common goals. The

design could encourage communication and collaboration, rewarding mutual help and equity. It could also carry over into work situations where collaboration and interaction are crucial. In the professional corporate environment, where exploration and reward motivate employees to participate in development activities, in gamified games, trackers may enjoy exploring virtual simulations to obtain rewards. Designing a system where exploration and resource accumulation are essential could appeal to this population. In sports competitions, dominators would be those players who constantly seek to improve their technical skills and strategies to beat their opponents. The tournament design could focus on intense challenges, where victory is achieved through skill and leadership on the field. Interactors could be players who enjoy collaboration and group tactics. The game design could promote effective communication between team members, encouraging joint decision making and rewarding fair, cooperative play. In turn, the design aimed at trackers could pursue an experience that includes interactive activities such as searching for information about players, accumulating points or collecting virtual prizes. Finally, in a medical setting, dominators could be doctors looking to excel in their field, interactors could be nurses who value collaboration and trackers could be researchers looking to discover new solutions. By adapting these profiles and components to different contexts, more engaging and motivating experiences can be designed for a wide variety of audiences.

In short, the development of GBL experiences for higher education is a challenging process that requires significant investment. Having a better understanding of how players relate to games is important to ensure that these experiences are successful, and having a validated instrument to understand player profiles is a positive step in this direction.

Appendix 1.

Gamertype scale

The scale measures your player profile in a learning environment in the form of a game. Put a cross ("X") on the number that best reflects your response on the scale provided below. There are no right or wrong answers, just express your opinion about the statements.

Totally Disagree 1	Disagree 2	Agree 3	Totally Agree 4

1. I like to interact, share ideas and learn as a team.	1	2	3	4
2. I love innovative games with scoring systems that cause surprise or uncertainty.	1	2	3	4

3. I consider that looking for new sensations in a game and enjoying its narrative and aesthetics is better than competing.	1	2	3	4
4. I am usually distracted when I collaborate with people in a game.	4	3	2	1
5. I consider scoring systems a good way to improve content learning.	1	2	3	4
6. I enjoy the collective experiences that are presented in the game world.	1	2	3	4
7. I like that you can see the ratings of other players on the leaderboards at the end of the game.	1	2	3	4
8. I only like to learn autonomously if I can solve problems that allow me to level up.	1	2	3	4
9. I usually make an effort in the game to win points and medals with the aim of making myself known.	1	2	3	4
10. I consider it important to improve my skills by winning in a competitive game that brings me rewards.	1	2	3	4
11. I consider myself a rebel, and I don't like to follow the rules of the game.	4	3	2	1
12. I like games that allow me to manipulate others in order to enhance my social reputation.	1	2	3	4
13. I usually plan for myself to achieve goals in the game.	1	2	3	4
14. I consider that to learn it is better to work in a team than alone.	1	2	3	4
15. I think that the use of badges, virtual medals or points in a game can help improve my reputation.	1	2	3	4
16. I usually make the most of the opportunities that arise in a game for my own benefit.	1	2	3	4
17. I like to improve my learning by looking for the limits of the game.	1	2	3	4
18. I prefer games where I can face others with the aim of disturbing.	1	2	3	4
19. Levelling up by exploring the game world is a good way to motivate myself to learn.	1	2	3	4
20. I like to overcome difficulties and master difficult tasks.	1	2	3	4
21. I enjoy interacting on discussion forums in a virtual training environment where my achievements can be seen.	1	2	3	4
22. I usually follow my own path, and I often let myself be guided by curiosity.	1	2	3	4
23. I prefer to improve my learning by creating social connections during the game.	1	2	3	4

24. I like to have an impact on others by making myself known through my achievements during the game.	1	2	3	4
25. Being independent is more important to me than working as a team.	4	3	2	1
26. I like that rankings and classification tables are used because I like to be the centre of attention.	1	2	3	4
27. Recovering the effort invested through points, prizes or badges is important to me.	1	2	3	4
28. It makes me happy to be part of a team and to be able to guide others in the game.	1	2	3	4
29. I enjoy group interaction through chat or other means of communication in real time.	1	2	3	4
30. I enjoy sharing my knowledge with others.	1	2	3	4

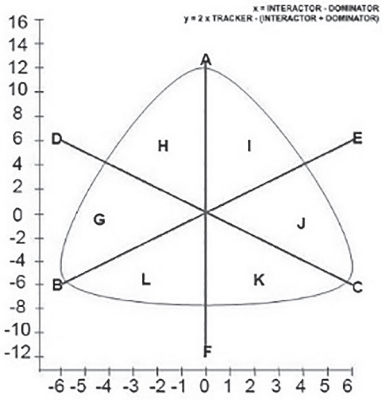
Value	Dominators	Trackers	Interactors
Low trend: **1.75-3** (summation between 10 and 17.5)	F (explorers)	D (tenacious)	E (seekers)
Moderate trend: **3.1-4.4** (summation between 17.6 and 25)	L (players)	H (achievers)	K (disruptors)
High trend: **4.5-7** (summation between 25.1and 32.5)	G (vehements)	I (conquerors)	J (socialisers)
Very high trend: **+5.7** (summation between 32.6 and 40)	B (raptors)	A (victors)	C (colleagues)

Dominator = 7 x (summation of items 5, 7, 9, 10, 12, 15, 18, 21, 24, 26) / 40
Tracker= 7 x (summation of items 2, 3, 8, 13, 16, 17, 19, 20, 22, 27) / 40
Interactor = 7 x (summation of items 1, 4, 6, 11, 14, 23, 25, 28, 29, 30) / 40

Axis x: Interactor – Dominator

Axis y: 2 x Tracker – (Interactor + Dominator)

Automatic measurement at www.joelprieto.eu



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