

The construction and validation of a Questionnaire of Gamification Skills in Teachers (QGST).

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Abstract. The objective of this study is to propose and validate a questionnaire that identifies gamification skills in teachers. In order to develop this instrument, a two-phase sequential exploratory design was used. In the qualitative phase, the specialized literature on gamification was reviewed, then the structure of the questionnaire, the dimensions and its indicators were obtained through the design of the items and the assessment of a panel of experts who validated the instrument. In the case of the quantitative phase, a pilot study was conducted with 203 teachers who used technology and active methodologies in their undergraduate and postgraduate classes; internal consistency tests, item analysis and both exploratory and confirmatory factor analysis were carried out with the obtained data. Among the results, it was found that the level and behavior of the items was adequate, their internal consistency is satisfactory, and the factor analyses allowed us to identify three dimensions and 22 items that allowed the proper identification of teachers' gamification skills, resulting in a valid and reliable tool for teachers who wish to get started with this new methodology.

Keywords: measurement, teacher, skills, gamification, questionnaire.

1 Introduction

The transformation of human activities linked to technological advances is undeniable. With the digitalization of productivity and services, a complete ecosystem has been created through those networks and applications that society uses to interact on their daily life.

In the last two years, due to school closures, confinement and social distancing after the health contingency caused by COVID-19, the increase and interest in the knowledge and use of technology has been exponential, and governments and researchers around the world have intensified their efforts to create digital agendas that could guarantee free access to technology, as well as to democratize learning through the extended classroom.

However, this systematic technological disruption [1] has become a challenge for educational institutions and their teaching staff due to the strong demand for quality teaching based on information technologies [2]. This demand increases the need to innovate on educational practices [3] [4].

This implies a reasoned process of decisions that allows progress towards the integration of methodologies, knowledge and technological resources into the teachers' practice [4] in order to achieve educational goals based on innovation ad hoc to the demands of today's society.

It is worth mentioning that innovation in educational practices goes beyond the incorporation of technology; it also involves problem solving features in the school context, fostering conditions for effective learning and motivation [5]. Innovating in education involves a continuous effort from both teachers and students to improve the conditions of the environment, whether physical or virtual, to increase the commitment to continue and successfully complete the academic programme [6].

One way to achieve engagement and motivation in the educational practices of teachers and students is the use of gamification [7], this strategy [8] is defined as the use of elements of games or video games in other contexts [9]. Gamification focuses on creating experiences, motivations and commitments, but unlike video games [10], it focuses on fields such as health, finance, government or education [11], with the aim of modifying the behavior of the user or customer in order to interest them [12] and motivate them towards a product or service [13].

Although several studies have shown that gamification has successful results in education [14], especially in the use of digital tools and the satisfactory experiences of teachers and students [15], there are still challenges such as the consolidation of this as a game-based educational methodology [16], overcoming the belief that gamification is synonymous with playing without a specific purpose [17] and that teachers have sufficient knowledge and skills for the development of activities based on gamification as a way of carrying out innovative educational practices both face-to-face and virtual [18].

Therefore, it is of particular interest that teachers and education specialists have the necessary skills to use gamification in their educational practices [19] to generate new learning experiences enriched with technologies [20]. The first challenge is to identify whether teachers have sufficient knowledge and skills to develop gamification strategies in the academic environment. To do so, a reliable and specialized instrument is required to help teachers identify their potential to use gamification in their educational practice.

Therefore, the objective of this research was to propose and validate an instrument that could be used to identify gamification skills in teachers.

2 Reference Framework

2.1 Gamification as an educational practice

As mentioned above, gamification has been successfully developed in various fields, most notably in education. A factor of acceptance towards this methodology is the thinking and culture of the game and video game that is rooted in current generations [21], in addition to the fact that it has theoretical foundations based on theories such as flow, self-regulation, intrinsic motivation and social learning [22], [23].

Gamification in education has proven to be efficient in student learning and, also, to be a factor of change in current innovative educational practices [24] since it motivates and encourages work [25], modifies behavior and promotes problem solving [22]; in addition, with the implementation of technology, it creates and improves student experiences in the courses where it is used [26].

As mentioned above, the main challenges are the lack of knowledge, misperceptions and beliefs of teachers that gamification is exclusive to one educational level or type of subject [27], that it implies an extra workload when designing activities [28], that it is necessary to use technology for its implementation [14], that game activities are developed losing sight of the learning objectives [29] and when the activities last a long time, they become monotonous tasks causing students to lose interest in the subject [30].

The general assessment of gamification as an educational practice is positive because it is considered an innovation in education [31] [32] and it focuses on the motivation and interest of students to continue their studies.

2.2 Gamification skills for teachers

With the current conditions in the educational area, teachers have managed to develop sufficient competences to conceive innovative educational practices [33], regardless of the level at which they teach, as well as in their academic life, they have achieved outstanding competences in the use of ICT (Information and Communication Technology and using emerging methodologies for their classes [34].

In the case of gamification, teachers present successful experiences in different areas and educational levels [35], [36], [37], which demonstrates the interest of education professionals in using this methodology, mainly because of the benefits it brings to the development of students teamwork, critical thinking, communication and social skills [17].

In addition, it has been found that some teachers use terms associated with gamification and game-based learning such as "badges", "awards", "leaderboards", "narratives", "progression", among others [38], however, many of them are unaware that they are doing gamification [39]. Although it is true that a sector of teachers considers that implementing this type of methodology is difficult, especially for those who teach in a traditional way [40], teachers recognize the need to use new teaching and learning mechanisms [41].

2.3 Measurement in gamification

There are various scales and questionnaires related to gamification, which are divided into three main categories: the first is to identify game experiences, such as the GAMEX (Gameful Experience in Gamification) [42] and GAMEFULQUEST (Gameful Experience Questionnaire) [43], aimed at identifying users' experiences of the service received.

The second category refers to the identification of the type of players involved in a game environment, such as the GUTHS scale (Gamification User Types Hexad Scale) [44], the GPQ (Game Preference Questionnaire) [45] and the HEXAD scale (Gamification User Types Hexad Scale) [46]. These instruments function as predictors for the design of Interactive Learning Events (ILES) [22] to be more appropriate to the characteristics of those who participate in them.

Finally, the third category focuses on the psychometric properties of gamification to theoretically validate this methodology, as it is the case of flow theory [47], the interest and motivation of participants to continue with the activities and strategies proposed [48], or the assessment of eight aspects related to the activity or service in relation to user motivation [49].

As can be seen, in these three categories the scales and questionnaires focus mainly on the experiences of those who participate in the game, other measurement instruments were also found in the context of gamification and game-based learning, especially aimed at indicating factors that contribute to the development of strategies through games [50], the assessment in the design of gamification resources through rubrics [51] and the identification of activities that can be considered gamification by finding dynamics, mechanics and aesthetics [52], [53].

3 Method

For the development of the questionnaire, a non-experimental type of research was carried out [54], using a Sequential Exploratory Design (SED). The SED was used due to its use for construction of measurement instruments when there are few standardized scales [55]. Its methodology was developed through a qualitative phase and another quantitative phase. Figure 1 shows the scheme followed in this research.

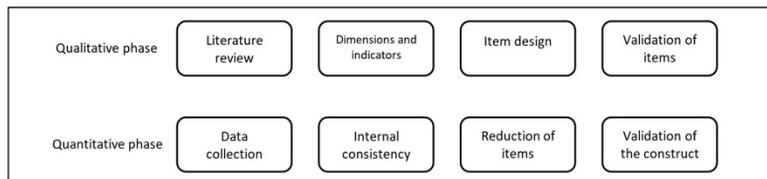


Fig. 1. Outline of work for the development of the instrument. Source: Own elaboration based on Mittal & Alavi's proposal [55]

3.1 Qualitative phase

The first stage was the definition of the construct and its dimensions, which consisted of a review of the specialised literature on the subject of gamification and its influence on educational practice. The analysis was mainly focused on scientific articles and book chapters hosted in databases such as Web of Science, Scopus and Eric. The search terms were "Gamification" AND "test" OR "questionnaire" AND teacher.

From this analysis 34 articles were obtained, 13 of which deal with the elements of gamification in education, 9 with gamification skills and competences that teachers should possess and 12 with scales for measuring gamification; these articles served as theoretical underpinnings for the framework of this work.

From this review, it was determined that the definition by Deterding et. al. [56] was the most appropriate for consideration in this research as gamification is "...a series of techniques or strategies pertaining to video games applied in a non-game environment to encourage customer participation and engagement". From the construct, three fundamental dimensions were defined: Skills (SK), Attitudes (AT) and Knowledge (KN) to design ILES [23].

For each dimension, a series of factors were obtained to identify skills that a teacher in the exercise of their profession commonly performs and that are related to gamification, such as the elements that are used in games for school activities [57], the use of various mechanics [21] for the achievement of motivation and engagement.

Based on the indicators, the items were designed by formulating them as statements in the teaching practice that inquired about the elements involved on gamification development. The dimensions, indicators and items are shown in table 1.

Table 1. Questionnaire dimensions, indicators and items

Dimension	Indicator	Items
Skills (SK)	Use of game mechanics and game components for school activities.	SK1, SK2, SK3, SK4, SK5, SK6,
	Relates gamification events to motivation and achievement of learning objectives.	SK7, SK8, SK9.
	Designs activities based on games or gamification events for modelling behaviors such as autonomy, engagement, attention, collaboration, among others.	
Attitudes (AT)	Willingness and openness to employ game strategies and mechanics in the context of their educational practice.	AT1, AT2, AT3, AT4, AT5, AT6,
	Recognizes the elements of play as a way of motivating learners.	AT7, AT8, AT9.
	Is concerned with the learning and development of competences in their students.	
Knowledge (KN)	Understands how game mechanics work to achieve learner motivation and engagement.	KN1, KN2, KN3, KN4, KN5, KN6,
	Designs materials for use in their game-based strategies.	KN7, KN8.
	Recognizes the operation of technological tools for the development of game mechanics and game components in education.	

Note: the list of items is in the appendix. Source: own elaboration.

A four-option Likert scale was used to answer the items: 1 Never, 2 Hardly Ever, 3 Usually, 4 Always.

For the validation of the items, the instrument was subjected to a concordance analysis by a panel of six experts who have worked in the area of gamification for education, from Spanish, Mexican, Chilean and Costa Rican universities, in order to reach a consensus in the analysis of each item of the instrument, taking into account its dimensions and the objective of the research [58].

The expert panel made a number of observations, mainly on the wording of the items so that they are at a level understandable to the participants, but also relate to activities linked to gamification, with an emphasis on alignment with the dimensions and their indicators; thus the items were intentionally designed to address panoramic aspects of game-based learning.

After making the adjustments, the first version of the questionnaire, which was named QGST (Questionnaire of Gamification Skills in Teacher), was available.

Finally, in order to identify the level of mastery in each dimension, it was determined to use the average of the scores obtained, at the general level and by domain. Table 2 presents the scale with the levels of mastery and their interpretation.

Table 2. Scale for QGST

Level	Value	Description
Outstanding	3 to 4	Uses various elements of gamification, possibly intentionally, and is willing to employ this methodology in their teaching practice.
Satisfactory	2 to 2.9	Uses some elements of gamification, possibly unconsciously but has a willingness to employ this methodology in their teaching practice.
Unsatisfactory	1 to 1.9	Uses few or no elements of gamification, may not be willing to employ this methodology in their teaching practice.

3.2 Quantitative phase

In this phase of data collection, higher education teachers from seven educational institutions in the state of Yucatan, Mexico were invited to participate in the pilot study.

Due to the nature of the study, inclusion and exclusion criteria were identified so that teachers would participate in the study (see table 3) and the results obtained would remain constant, eliminating possible biases during the time the research lasted and so that the research would be reliable and valid [59].

Table 3. Criteria for participation in the study

Inclusion	Exclusion
Be teachers who teach undergraduate and postgraduate classes.	Be a primary or secondary school teacher.
Demonstrate the use of information and communication technologies in their classes.	Not be teaching at the time of the research.
Employ active methodologies [60] in their educational practice.	

Initially there was a group of 210 teachers, but when the participation criteria were applied, the number was reduced to 203. Table 4 shows the distribution of the participants and their general data.

Table 4. Number and characteristics of teachers who participated in the study

Institution (Key)	n	Women	Men	Scholarity		
				Technician	Degree	Postgraduate
A	33	15	18	0	9	24
B	17	8	9	0	4	13
C	30	9	21	0	1	29
D	31	10	21	9	7	15
E	27	20	7	7	6	14
F	34	32	2	2	6	26
G	31	13	18	2	4	25
Totals	203	107	96	20	37	146

The distribution of QGST was carried out digitally during the month of January 2022 using a *Google form*. The information collected was integrated into a database for statistical testing.

In the internal consistency stage, descriptive analyses of the items were carried out to identify their behavior in terms of variability and trend, which consisted of the mean of the scores (X), median (M_d), Standard Deviation (S_d), Skewness (S_w), Kurtosis (K_u), Minimum (M_i), Maximum (M_a) [61], the corrected homogeneity index (C_{hi}) and discrimination index (D_i) [62] and the item-total correlation of the questionnaire (I_{it}), which would allow a first elimination of items [63].

In this same stage, the Cronbach's Alpha α and McDonald's Omega ω coefficients [64] were obtained to confirm the reliability of the instrument in terms of its dimensions.

Table 5 presents the acceptable and optimal values of the analysis carried out on the instrument.

In the item reduction stage, exploratory factor analysis (EFA) of principal components was carried out to determine the factor loadings of the instrument [65], whose values greater than .5 were considered acceptable, otherwise (<.5) the item would be deleted from the instrument.

Table 5. Expected values at the internal consistency stage of QGST

Analysis Type	Acceptable	Optimal
C_{hi}	<.3	>.7
I_{ti}	>.3	>.5
D_i	<.05	<.01
α & ω	>.6	>.9

The confirmatory factor analysis (CFA) would allow the robustness of the model proposed by means of the fit indices, which in this research used the chi-squared ratio over degrees of freedom (CMIN/DIF), comparative fit index (CFI), root mean square error of approximation (RMSA), goodness of fit index (GFI), normed fit index (NFI), root mean square root of squared residuals (SRMR) and incremental fit index (IFI) [66].

In order to carry out the CFA, the instrument was administered with the adjustments based on the results obtained from the EFA to another group of teachers who have the same characteristics as the participants in this research and to whom the same criteria established in table 2 were applied in order to have consistency in the results.

The statistical software used for the descriptive analysis was the SPSS programme, for the internal consistency tests and the EFA the free programmes Jamovi¹ and JASP² were used, and these same, together with the AMOS programme, were used to obtain the different values of the CFA.

We also analysed the data obtained from participants who initially responded to the QSGT, using the mean scores and according to the scale in table 2.

3.3 Ethics

All participants were notified of the purpose of the research, were not asked for any associated data that could reveal their identity, and the names of the participating institutions were replaced by keys as shown in table 3.

4 Results

Based on the proposed design, the results are presented in two sections. The first consisted of a descriptive study of the items and the reduction of these items by means of the EFA and CFA.

¹ <https://www.jamovi.org/>

² <https://jasp-stats.org/>

4.1 Descriptive study of items

Item analyses were carried out on the database and integrated into table 6 for review:

Table 6. Item Analysis

Item	X	M _d	S _d	S _w	K _u	M _i	M _a	C _{hi}	I _{ii}	D _i
SK1	2.01	2	1.05	0.649	-0.819	1	4	.546	0.582	.000
SK2	2.88	3	1.04	-0.515	-0.886	1	4	.687	0.413	.000
SK3	2.13	2	1.04	0.375	-1.100	1	4	.536	0.665	.000
SK4	2.92	3	1.10	-0.668	-0.875	1	4	.406	0.635	.000
SK5	3.10	3	0.92	-0.699	-0.459	1	4	.646	0.500	.000
SK6	2.35	2	1.17	0.154	-1.470	1	4	.579	0.456	.000
SK7	3.20	3	0.89	-0.958	0.182	1	4	.459	0.631	.000
SK8	2.91	3	0.91	-0.632	-0.278	1	4	.539	0.700	.000
SK9	2.58	3	1.08	-0.0742	-1.250	1	4	.611	0.468	.000
AT1	3.31	3	0.73	-0.961	0.828	1	4	.387	0.552	.003
AT2	3.20	3	0.86	-0.888	0.110	1	4	.478	0.424	.000
AT3	3.46	4	0.72	-1.18	0.691	1	4	.332	0.408	.004
AT4	3.54	4	0.63	-1.06	0.056	1	4	.460	0.525	.002
AT5	3.73	4	0.57	-2.41	6.670	1	4	.352	0.788	.002
AT6	3.24	3	0.88	-0.934	-0.025	1	4	.608	0.480	.000
AT7	3.10	3	1.00	-0.903	-0.248	1	4	.495	0.669	.000
AT8	2.99	3	0.75	-0.161	-0.73	1	4	.599	0.447	.000
AT9	3.24	3	0.71	-0.386	-0.964	1	4	.520	0.568	.000
KN1	2.69	3	1.06	-0.118	-1.250	1	4	.588	0.616	.000
KN2	2.06	2	1.07	0.633	-0.859	1	4	.548	0.638	.000
KN3	2.90	3	0.98	-0.602	-0.608	1	4	.643	0.532	.000
KN4	2.55	2.5	1.12	-0.0181	-1.370	1	4	.685	0.439	.000
KN5	3.41	4	0.688	-0.992	0.759	1	4	.301	0.723	.014
KN6	3.39	3.5	0.703	-0.935	0.515	1	4	.355	0.299	.003
KN7	3.30	3	0.701	-0.720	0.240	1	4	.327	0.216	.003
KN8	2.98	3	0.763	-0.309	-0.341	1	4	.414	0.643	.000

It is observed that the behavior of the items based on the participants' responses was as expected; however, attention is drawn to KN6 and KN7 since the I_{ii} is below the established criteria, although the C_{hi} and I_d were adequate; therefore, it was decided to maintain them.

Table 7. Reliability indices (Cronbach's Alpha and McDonald's Omega)

Dimension	α	ω
SK (nine items)	0.842	0.844
AT (nine items)	0.815	0.826
KN (eight items)	0.796	0.805
Total	0.911	0.911

In the internal consistency tests, the Alpha and Omega indices were obtained; in this case, these tests were carried out by dimension and for the questionnaire (see table 7).

The indices obtained are considered good for each dimension, no item had to be deleted to increase the values. For the whole instrument these indices were very good, therefore, QGST is considered a reliable questionnaire.

4.2 Reduction of items

Prior to the EFA, the KMO test (0.793) for sampling adequacy and Bartlett's sphericity test were carried out, with values ($X^2= 1138.414$, $df=325$, $p=.00$), which are adequate to continue with the Factor Analysis. Table 8 presents the results of the factor loadings:

Table 8. Factor loadings of each item

Item	Factor		
	Fc1	Fc2	Fc3
SK1	0.591		
SK2	0.750		
SK3	0.568		
SK4	0.663		
SK5	0.674		
SK6	0.761		
SK7		0.510	
SK8	0.415*		
SK9		0.595	
AT1		0.715	
AT2		0.748	
AT3		0.811	
AT4		0.686	
AT5		.0492*	
AT6		0.616	
AT7	0.562		
AT8			0.656
AT9			0.551
KN1	0.513		
KN2	0.567		
KN3		0.493*	
KN4	0.690		
KN5			0.457*
KN6			0.859
KN7			0.881
KN8			0.624

Notes: Extraction method, principal components, varimax rotation. * $<.5$. Source: own elaboration.

It is observed that the factor loadings of the items in which three factors were extracted explained 51.7% of the variance. From this analysis the items SK8, AT5, KN3, KN5 were removed from QGST.

With those obtained from the EFA, the instrument was adjusted and administered to 112 teachers for the CFA, whose indices did not initially adjust to the reference levels, so the estimation method was modified by the DWLS [67], so that finally the appropriate values were obtained, which are presented in the table 9.

Table 9. CFA carried out on the QGST

Fit measures	Reference level	Initial model	Final model
CMIN/DIF	2-5	2.63	3.20
IFI	>0.9	0.923	0.977
CFI	>0.9	0.766	0.977
NFI	>0.9	0.0894	0.908
RMSEA	<.06	.0902	0.039
GFI	>.09	.689	0.771

It is observed that the parameters of the final model adjusted at the reference levels of each of the indices, indicating that the construct has been validated and that the three factors that were extracted in the CFA are adequate.

Finally, the structural equation model was performed, which is presented in Figure 2.

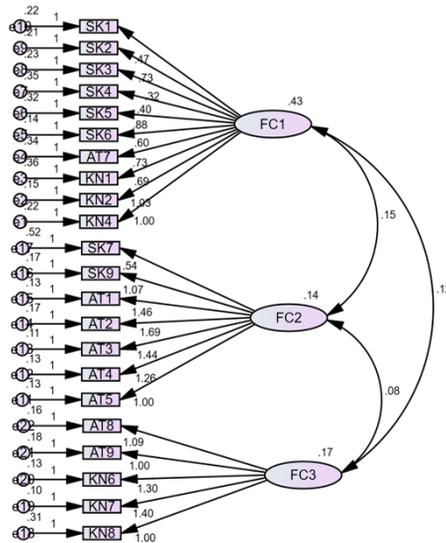


Fig. 2. Final model from the CFA of the QGST

4.3 Resultant Dimensions

Based on the EFA and CFA, three dimensions (factors) of the instrument were identified, as well as a reorganisation of the items as can be seen in table 8 and figure

2, so it was decided to modify the dimensions in terms of their definitions and the gamification thinking process that a teacher can develop.

The first dimension (FC1) aims to show knowledge and skills related to the fundamentals and use of game mechanics and components for school activities, as well as the design of materials to be used in their educational practices. This dimension was named *Design of Gamification-based Activities*

The second dimension (FC2) was named *Interest towards gamification*. It contains elements related to the willingness and openness to employ strategies and mechanics of games and video games. It also shows if the teacher recognizes gamification as a way to motivate their students, and the implication of innovative educational practices, with creative activities for the development of critical thinking, communication and socialization.

Finally, the third dimension (FC3) is called *Conceptualization of the idea of gamification*. It consists of the definition and characterization of gamification, i.e. the analysis of the school context (selection and use of tools and technological resources) and the individual characteristics of students (such as learning rhythms and styles), as well as the subject programme or expected learning in terms of the relevance and feasibility when incorporating a variety of teaching and learning strategies through gamification.

4.4 QGST characteristics

Based on the results and the analysis performed, Figure 3 represents the final characteristics of the teacher gamification skills questionnaire (QGST).

QGST	
Feature	Description
Skills tested:	- Design of gamification activities (FC1) - Interest Towards Gamification (FC2) - Conceptualization of the idea of gamification (FC3)
Language:	Spanish/English
Mode of administration:	Online
Number of items:	22
Response format:	Multiple choice, four alternatives
Target population	Higher education teachers
Time to complete the questionnaire:	15 minutes approx.
Tests	
Reliability – Total Test:	$\alpha = .900$ $\omega = .900$
- FC2	$\alpha = .837$ $\omega = .844$
- FC3	$\alpha = .825$ $\omega = .833$
- FC1	$\alpha = .874$ $\omega = .876$
Standard error of measurement:	
- Total	0.161
- FC2	0.236
- FC3	0.228
- FC1	0.255

Fig. 3. Characteristics of QGST. Source: own elaboration.

4.5 Findings

Some relevant results were found from the data collected from the research participants; the mean score of the QSGT was ($X = 2.99$, $SD = 0.415$), so, according to the scale defined in table 2, it is considered as "satisfactory", on the other hand, when

analysing the means in the three dimensions evaluated by the instrument, the results shown in figure 4 were obtained.

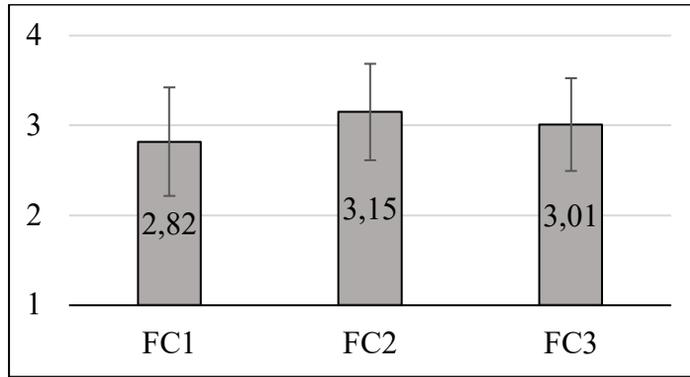


Fig. 4. Participants' scores on the three dimensions of the QSGT. Source: own elaboration.

Both dimensions FC2 and FC3 are considered according to the QSGT scale as "outstanding", while FC1 is considered as "satisfactory".

The means of each dimension and of the total QSGT scale were also compared by grouping the participants by school. The results obtained are shown in figure 5.

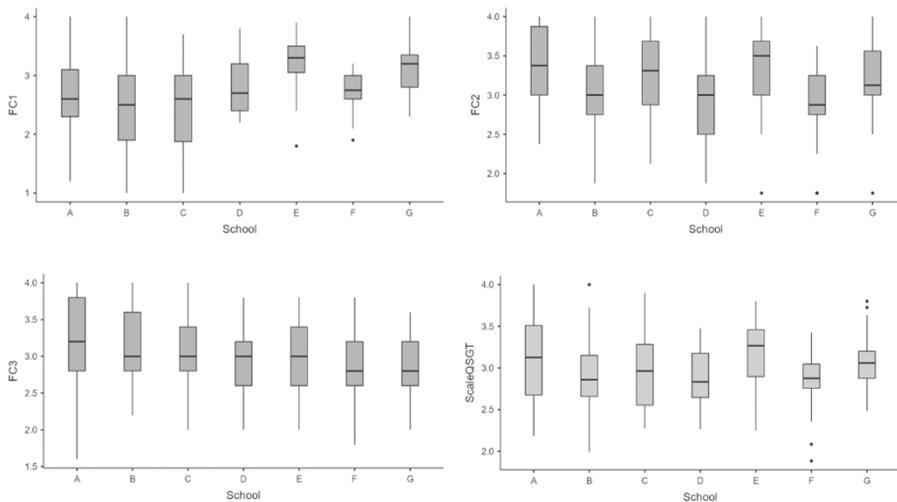


Fig. 5. Participants' means of the QSGT by school. Source: own elaboration.

It was found that the participants of three of the seven schools are at the "outstanding" level and the others are at the "satisfactory" level; in the case of the

dimensions, in relation to FC1 two schools are at the "outstanding" level, in the case of FC2 there are five schools and FC3 has three schools at this level.

5 Discussion

The QGST arises from the need to have a primary instrument that would obtain information on the conception, knowledge, skills and attitudes that teachers have towards gamification. Based on the literature review of other instruments, the QGST is an unprecedented proposal aimed at teachers.

One of the priorities was to obtain relevant and useful information based on the recognition of the use of gamification as a learning strategy that can be developed in teachers. A first step was the construction and validation of the questionnaire to serve as a self-report for teachers and for pre-service and in-service teacher training institutions. For this reason, the questionnaire can be used by teachers in formation, practicing teachers, as well as educational researchers.

The initial concern of the authors of this article is that the skill of gamification is often underrated; however, it should be targeted and included as an alternative teaching strategy in all academic teacher professional development programmes. Despite this, gamification is currently still perceived as something that "only a few" can use, where misconceptions or misbeliefs are involved. In order to design learning paths, it is necessary to recognize the teacher's starting point. This is what the QGST seeks to do.

Suggestions on how to interpret the results of the questionnaire are based on the three dimensions, although it is possible to make an item-by-item analysis, which gives specific details about a particular attitude, knowledge or skill. Through its three dimensions, it provides relevant information about the stage of teachers' thinking about gamification, and thus relates it to teacher professional development programmes. In such way, it is possible to design training cycles for teacher formation in order to develop gamification as a didactic strategy.

The results of the analysis and the proposal of dimensions are based on the available theoretical frameworks related to the skills that teachers possess, the implementation of gamification in education in any of its modalities and the theories that support them as a way to achieve motivation and commitment of students to continue with their studies.

The information obtained collectively in each school will allow those responsible for teacher training institutions to design a variety of strategies for training or updating teachers in the acquisition and deepening of attitudes, knowledge and skills related to the use of gamification in the classroom. This can be developed as a comprehensive teacher training plan.

Additionally, researchers can use QGST to compare with various teaching and learning strategies (e.g., collaborative learning, project-oriented learning, problem-based learning) and assess their relationship with other factors (e.g. academic performance, motivation towards learning, level of competence development, teacher's academic history).

The QGST was created to be administered online, which makes it easy to administer, respond and analyze. It is even easy to respond on any device such as a mobile phone, tablet or personal computer. Its empirical basis makes it possible to identify techniques or strategies belonging to video games applied in teaching practices in non-game environments that encourage participation and the desire of students to continue with the course they are teaching.

6 Conclusions and further work

The results of the statistical analysis confirms that the teacher gamification skills questionnaire is a valid and reliable instrument. Based on its frame of reference and characteristics, the number of items, its dimensions, the time to answer and the rating scale, the future use of the questionnaire on academic research is confident.

However, some remaining tasks include the validation of the instrument with teachers at different levels of education (e.g. primary, secondary and high school), in different contexts (e.g. urban, rural, community) and educational settings (e.g. public and private).

In addition, more research is needed on its use and implications with other variables, such as the technological infrastructure of the institutions, or the identification of teacher proficiency levels in the use of gamification in the classroom. Important tasks to be taken into account for future research.

One limitation that must be addressed for this study is that the target population were Mexican teachers at higher education level. It is hoped that future research can confirm the findings presented here, in other countries and contexts. Given that this is a self-reported questionnaire, it will still be necessary to incorporate classroom observations and performance tests, among other methodological techniques.

In conclusion, the QGST is a first instrument, which due to its metric properties, will allow us to obtain information on the conceptions, attitudes, knowledge and skills that teachers have regarding gamification as a didactic strategy. Its design, items, dimensions and specific characteristics based on the reference frameworks of gamification, allow it to be a useful tool for understanding what teachers think, conceptualize and practice in their classes, and once that the information is collected.

It can serve as a diagnosis for outlining itineraries for updating and professionalizing teachers to use gamification as a teaching strategy. It is hoped that future research will allow us to deepen our understanding of teachers' professional thinking and knowledge of gamification as a teaching strategy and provide more elements for its understanding, as well as its incorporation into initial and ongoing teacher training programmes.

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Appendix

QSGT items

First version	Final version
SK	FC1
<ol style="list-style-type: none"> 1. I use a ranking system (such as league tables) to generate competition among my students. 2. I use a reward system (prizes, points, awards, etc.) to motivate my learners to do the activities. 3. I award badges or emblems to encourage my students to study or perform a particular action in my class. 4. I develop a points system that allows students to be able to monitor their own progress during the course. 5. I use challenges to encourage autonomy and self-regulation in my students' learning. 6. I use a system of levels where students can move up through the ranks by correctly completing one activity after another. 7. I use narratives or stories to make my students pay more attention to the class sessions. 8. I employ a role system where each student has a specific function in the classroom. 9. I use a system of hints where the student finds answers to their learning. 	<ol style="list-style-type: none"> 1. I use a ranking system (such as league tables) to generate competition among my students. 2. I use a reward system (prizes, points, awards, etc.) to motivate my learners to do the activities. 3. I award badges or emblems to encourage my students to study or perform a particular action in my class. 4. I develop a points system that allows students to be able to monitor their own progress during the course. 5. I use challenges to encourage autonomy and self-regulation in my students' learning. 6. I use a system of levels where students can move up through the ranks by correctly completing one activity after another. 7. It is important for my students to be competitive with each other in order to work on their self-esteem. 8. I include complementary activities so that my students get extra points. 9. I develop a reward system that encourages teamwork and student collaboration. 10. I select rewards according to the tastes and preferences of my students.
AT	FC2
<ol style="list-style-type: none"> 1. I have the desire to use a game in my classes. 2. I am motivated to use games in my lessons. 3. I find that the rules or systems of games can be useful in designing my learning activities. 4. I am satisfied that my students learn while having fun. 5. It is important for my students' learning to collaborate with each other to solve a given challenge. 6. I make classes more dynamic by encouraging student participation through playful activities or games. 7. It is important for my students to be competitive with each other in order to work on their self-esteem. 8. I consider that the activities I use are innovative for the students. 9. I develop creative learning activities for my students. 	<ol style="list-style-type: none"> 1. I use narratives or stories to make my students pay more attention to the class sessions. 2. I use a system of hints where the student finds answers to their learning. 3. I have the desire to use a game in my classes. 4. I am motivated to use games in my lessons. 5. I find that the rules or systems of games can be useful in designing my learning activities. 6. I am satisfied that my students learn while having fun. 7. It is important for my students' learning to collaborate with each other to solve a given challenge.
KN	FC3
<ol style="list-style-type: none"> 1. I include complementary activities so that my students get extra points. 2. I develop a reward system that encourages teamwork and student collaboration. 3. I develop audiovisual material that is able to attract the attention of my students. 4. I select rewards according to the tastes and preferences of my students. 5. I consider the learning style of my learners when designing my activities. 6. I use technological tools to promote student involvement and interest. 7. I select the most appropriate technological resource for the teaching strategy I use. 8. I avoid using the same teaching and learning strategies from presental to virtual and vice versa. 	<ol style="list-style-type: none"> 1. I consider that the activities I use are innovative for the students. 2. I develop creative learning activities for my students. 3. I use technological tools to promote student involvement and interest. 4. I select the most appropriate technological resource for the teaching strategy I use. 5. I avoid using the same teaching and learning strategies from presental to virtual and vice versa.