

Metric properties of a Gamification Scale in university students

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Summary

The purpose of this study was to evaluate the metric properties of the Gamification questionnaire scale in a sample of 462 university students; of them, 73.1% are male; 26.3% were female and 0.6% preferred not to express themselves; the average age of the participants was 18.5 with a standard deviation of 2.55, who responded to the questionnaire scale for the exploratory and confirmatory factor analysis procedures, detecting three components as the subscales, presenting a high index level and an adequate parsimonious model. The results showed high reliability with Cronbach's alpha and concordance with the Aiken index; likewise, the confirmatory factor analysis detected three factors: dynamism, information acquisition and feedback with a total explained variance of 78.228% who were corroborated by the confirmatory analysis and the indices of the structural equations.

Keywords: Gamification, exploratory and confirmatory analysis, dynamism, information acquisition, feedback

Introduction

The study allowed detecting the analysis and standardization of a measurement scale based on the perception of university students towards planned gamification during learning sessions as a dynamic, activating, motivating element during ubiquitous scenarios (María et al., 2015). The methodological sequence of the investigation detected that the scale put into consideration by the Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) procedures show

statistically significant parameters and coefficients.

The psychometric contributions of a scale proposed by Ramos Vargas (2016) provided the approximation to the theories, methods and techniques that allowed the sustenance of the phenomena associated with gamification from the subjective perceptions of the student, who allowed detecting visible indicators thanks to the behavioral manifestations by the scale of the instrument. Using theories, sequences and techniques related to the development and

administration of tests, psychometry is based on the measurement of psychological phenomena in order to describe diagnoses, explain and predict for decision-making about the behavior of the respondent (Lloret et al., 2017).

In this regard, Resett y Gámez-Guadix (2018b) they evaluated the psychometric properties of the Cyberbullying Questionnaire in university students through exploratory and confirmatory factor analysis, which detected a Cyberaggression subscale and two Cybervictimization subscales through a structural equation model.

Regarding the educational processes at the different levels of the educational system, they have undergone a major renovation due to the insertion of digital tools for both teaching and learning (Raju et al., 2021). Gamification is a relatively recent trend in our environment and even more so in higher education students that has been paying considerable attention and interest to their use of different tools (Saleem et al., 2021). Gamification involves a variety of gameplay techniques that turn a task into an attractive and playful act, it is also a technique that is based on the elements that make games attractive, allowing users to be involved in an environment that makes learning fun (Marín Díaz, 2016). it is the adhesion of elements and techniques typical of the development of games to learning contexts (Marín Díaz, 2015).

Para Vélez Meza et al. (2020), the emergence of new technologies inserted in teaching and the development of new active methodologies favorably lead learning, arousing interest and motivation; likewise, feedback actions, cooperative and collaborative participation (Andriani et al., 2019 and Ortiz-Colón et al., 2018). In addition, the methodological sequence provides a great opportunity to promote effort, loyalty and cooperation, since gamification acts as a dynamic element within the educational process.

Gamification establishes a dynamic and interactive link between students and teachers, allowing them to improve knowledge and skills during the use of virtual materials, adapting them to the new experiences and expressive forms of the digital society.(Prieto Andreu, 2020). The gamified learning materials emphasize the interactive experience of the student in higher education, allowing to strengthen the commitment in participation and increasing the motivation for what they are learning.

Para Ortiz-Colón et al. (2018), the society of knowledge and technology in this new generation have allowed new interests and interactions with contemporary strategies and resources (Pérez-López et al., 2017). It is necessary to insert the dynamics of the game, mechanics and components during the gamification in the pedagogical processes with the aim of a lasting, significant learning, above all, of the way of acquiring information in an interactive way. For its part, para Aguilar y Ramos (2016), it is important to keep in mind the perceptions of students to gamification and pay attention to the methodological sequence during learning in university students.

As stated, statistics, indices and graphic structures have been detected sequentially by Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA); According to Elosua (2011), the development of these techniques is appropriate for the validation and adaptation of psychological measurement instruments, articulating four main stages: 1) the type of data and the association matrix, 2) the factorial estimation method, 3) the number of factors to retain and 4) the rotation method. (Lloret et al., 2017 and Tobón et al., 2018), the validation is typical of the items, reagents or questions of the data collection instruments (Ramos, 2019), the use of software and programs such as SPSS, FACTOR, PRELIS and MPlus depending on the nature of the data, is feasible in these calculation scenarios of robust statistics. For

the effect of the study by SPSS and the AMOS extension, which detected the components according to the behavior of the data.

Gamification components

The dynamism . According to Marín Díaz (2016), it is characterized by constant changes in activity, where learning lives, grows, connects and extends beyond the limits of the classroom and physical location. For Ramos (2016), this action manifests itself with the manipulation and use of gamification tools. As an indicator we have motivation; Due to their nature, they show high attractiveness, allowing the student to generate the attention fixed on the activities, allowing the reinforcement of various themes. And as an interest, the participant learns on their own initiative in real time, the successes to the activities are rewards with positioning, nomination letters, among others, generating initiative in the next participations.

The acquisition of knowledge . Según Resett y Gámez-Guadix (2018a), is understood as the cognitive processes of learning and the development of intelligence through virtual resources to face the challenges of our contemporary society (Andriani et al., 2019); this component demands commitment and recognition during participation; Regarding the commitment, it demands voluntary and dynamic participation during the participation for the learning of the gamified subject . While the recognition involves waiting for notifications by the tool through letters, recognition, achievement levels and public recognition by the teacher and peers.

Feedback . Según Blasco-Serrano et al. (2018), Within the virtual scenarios, the feedback consists of reinforcing in real time the student's weaknesses and achievements or progress in relation to the expected instructions, avoiding unsubstantiated criticism. Para Dias et al. (2021), this act allows the student to compare what he should have done and what he tried to

achieve with what he actually did, these can be: visual clues, signals of correct or incorrect response or behavior and statistics of the player's performance. The study identified two components: mechanics and interaction. The mechanics, refers to the ease of use of the tools and the different forms of rewards and incentives of competition (Canet-Juric et al., 2013); In terms of interaction, the fact of participating and comparing the answers of the other members allows reformulating responses to the questioning instantly, demonstrating security and intrinsic strength.

Materials and methods

Participants

In order to achieve the objective of this study, a non-probabilistic intentional sample (Salazar, 2018) of 462 university students who were studying in different professional engineering careers enrolled in the Mathematical Complements course was detected, distributed as a percentage: 38.5% Computer Systems Engineering students, 31.4% Civil Engineering, 18.6% Industrial Engineering, 2.6% Environmental Engineering, 3.8% Mechatronics Engineering, 1.9% Business Engineering, 3.2% Electronic Engineering; of them, 73.1% are male; 26.3% were female and 0.6% preferred not to express themselves; It has been detected at an average age of 18.5, between 17 and 41 years old, with a standard deviation of 2.55.

Instruments

The questionnaire allowed the collection of sociodemographic data: student code, professional career, gender, age and, properly speaking, the perceptions of gamification from the scale determined in the questionnaire designed in the Drive form.

The questionnaire is made up of three subscales: a) dynamism made up of 9 items, made up of two indicators; motivation (5 items) and interest (4 items). b) Acquisition of information, composed of 6 items, distributed in two indicators: commitment (3

items) and recognition (3 items). Finally, c) feedback, made up of 7 items, made up of two indicators; mechanics (3 items) and interactions (4 items). The response format used to evaluate the frequency of each item was 1 (totally disagree), 2 (disagree), 3 (agree), and 4 (totally agree); the directionality of the questions, for the most part, were positive, only the question with code ret_19 presents a negative orientation with a statement of *the competencies generated with gamification, it does not allow my learning*, which, for the analysis, their answers were inverted to assume them in a way set in information processing.

Procedures and data analysis

In principle, the director of the Department of Sciences of the University learned the use of gamification tools during the virtualized learning sessions, from which questions and cross-questions were generated and then systematized in a virtual questionnaire prior to the opinion of the experts. , informed consent was immediately requested from the student (Abella et al., 2014 y Tobón et al., 2018); for their participation with the granting of their answers to the questionnaire, having as a decision alternative: yes I accept / I do not accept, under this sequence the questionnaire was applied ensuring the confidentiality and anonymity of the answers. The data was analyzed in SPSS_25 and the SmartPLS 3 program for factor analysis and the AMOS 25 extension for structural equations (Abad-Segura et al., 2020) in order to detect endogenous, exogenous and observed variables with their respective measurement

errors, prior to the Exploratory and Confirmatory Factor Analysis. for independent samples, (Mayhew et al., 2020). One of the models that would be tested was the one postulated by the author of the instrument (theoretical model) and the other, the one derived from the exploratory factorial analysis in the sample (empirical model) (García Jiménez et al., 2000) and the Pearson correlation coefficient allowed evaluating the concordance of the variables and the proximity of the validity of the items of the questionnaire were significant, in addition, a model of structural equations was explored (Alaminos-Chica et al., 2015), which allowed detecting the flow of the observable variable and its three components with their respective errors.

Results

The procedures for the validity and reliability of the Gamification Scale (GA) instrument were the criteria established for this purpose. Regarding content validity (Latorre et al., 2020), five experts were put to consideration for their opinions, which were systematized; the results show a high level of concordance detected by the V Aiken technique = 0.83, obtaining the significance value $p_value < 0.05$ (Reivan-Ortiz et al., 2019), in addition, the concordance of the components of the scale, dynamism 0.973, information acquisition 1.00 and feedback 0.992 have been detected. , it presents a high level of statistical significance through the technique of validity by the Binomial statistic (Gil-Flores, 2003; Meléndez et al., 2009), typical for dichotomous decision instruments.

Table 1

Internal reliability of the Gamification questionnaire

Item Total Statistics

		Cronbach's Alpha		
code _	items	overall correlation	upper element	Sig_p < 0.00
din_1	Gamification improves my level of attention	0.805	0.947	Next _ ***
din_2	The use of gamified activities reinforces my learning of the course	0.807	0.946	Next _ ***
din_3	I enjoy learning through gamification.	0.801	0.947	Next _ ***
din_4	The use of gamified activities is appropriate in learning the topics of the course.	0.771	0.947	Next _ ***
din_5	Competition through gamification reinforces my learning.	0.792	0.947	Next _ ***
din_6	The interaction with gamification is entertaining.	0.787	0.947	Next _ ***
din_7	Gamification during class arouses my interest in learning.	0.822	0.946	Next _ ***
din_8	Competition through gamification reinforces my learning.	0.841	0.946	Next _ ***
din_9	The teacher shows interest in the use of gamification tools	0.718	0.948	Next _ ***
acq_10	The knowledge acquired in my study before	0.712	0.948	Next _

	the synchronous class makes it easier to answer the gamified questions .			***
acq_11	Starting the class synchronously with gamification helps me to be attentive in class.	0.676	0.948	Next _ ***
acq_12	I show a good predisposition when interacting with gamification.	0.737	0.948	Next _ ***
acq_13	I enjoy answering course questions through gamification	0.682	0.948	Next _ ***
acq_14	The way the course questions are presented is entertaining.	0.691	0.948	Next _ ***
ret_16	The rewards for solving the questions in the course motivate my participation.	0.383	0.953	Next _ ***
acq_15	I need a stimulus or reward to interact	0.689	0.948	Next _ ***
ret_17	Receiving virtual recognition during gamification activities motivates my learning	0.355	0.954	Next _ ***
ret_18	The teacher solves the technical problems that arise during the gamification	0.635	0.949	Next _ ***
ret_19	The skills generated with gamification do not allow my learning.	0.656	0.949	Next _ ***
ret_20	You ask the teacher your doubts generated	0.513	0.951	Next _

	when solving the gamified questions .			***
ret_21	At the end of the synchronous class, the teacher solves the gamified questions .	0.633	0.949	Next _ ***
ret_22	You absolve the errors you had when answering the gamified questions with your teacher.	0.632	0.949	Next _ ***

Cronbach's Alpha: 0.951, Kaiser-Meyer- Olkin Measure of Sampling Adequacy

KMO = 0.934

Bartlett sphericity test: Approx. Chi-square 4043.66 sig. 0.000

The results in table 1 show a high level of reliability detected by Cronbach's Alpha of 0.951 with 22 items; in this regard, it Baena (2017) presents a high level of internal validity. To evaluate the factor structure of the questionnaire, an Exploratory Factor Analysis (EFA) of the scale was carried out (Zapata-Cardona, 2018); the extraction of eigenvalues greater than 1 and an Oblimin Table 2

rotation . The calculation of the Kaiser-Meyer- Oklin sample adequacy index (KMO = 0.934) and Bartlett's sphericity test with ($\chi^2 = 4043.66$; $p < 0.001$) indicated that it was appropriate to carry out the CFA (Alaminos-Chica et al., 2015; Mateus-Galeano y Céspedes-Cuevas, 2016; Resett y Gámez-Guadix, 2018a).

Components from the total explained variance

Total explained variance

Component	Sums of squared extraction						Sums of loads squared of			
	Initial eigenvalues			loads			rotation			
	Total	varianc e %	% accumulate d	Total	varianc e %	% accumulate d	Tota l	varianc e %	% accumulate d	
one	11,95	54,359	54,359	11,95	54,359	54,359	8,05	36,620	36,620	
	9			9			6			

two	3,229	14,676	69,035	3,229	14,676	69,035	5,81	26,440	63,060
							7		
3	2,022	9,193	78,228	2,022	9,193	78,228	3,33	15,168	78,228
							7		
4	0.773	3,515	81,743						

Extraction method: principal component analysis.

According to the results of the total explained variance prior to the factorial analysis (Alaminos-Chica et al., 2015; Peixoto et al., 2019), the results of the table show that with three factors (component) they explain 78.228% of the variance, 63.06% with two factors and 36.62% with one factor, respectively; this argument Table 3

confirms the points of the sedimentation graph. Meléndez et al. (2009) show three upper points from the eigenvalue value 1 and the graph of components in rotated space, where the three components determined by the items of each component can be seen as a nearest neighbor cluster.

Factor loadings for the gamification scale questions

Component Array rotated ^{to}

	Component		
	Component 1	Component 2	Component 3
din_6	0.922		
din_3	0.907		
din_5	0.905		
din_2	0.904		
din_7	0.902		
din_8	0.896		
din_1	0.892		

din_9	0.888	
din_4	0.888	
adq_14	0.862	
dq_13	0.848	
adq_11	0.831	
adq_12	0.824	
adq_15	0.751	
acq_10 ret_22	0.655	
		0.844
ret_21		0.433
ret_17		0.875
ret_16		0.811
ret_18		0.750
ret_19		0.638
ret_20		0.584

Extraction method: main components.

Rotation Method: Varimax

to. The rotation has converged in 5 iterations.

Only values greater than 0.4 are shown

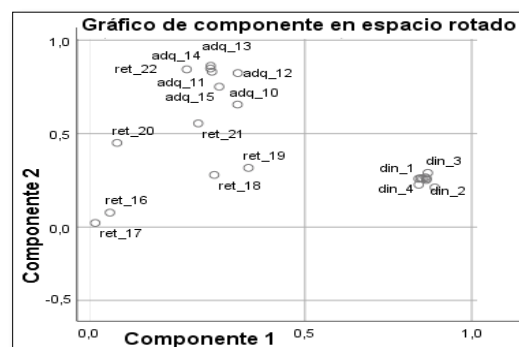
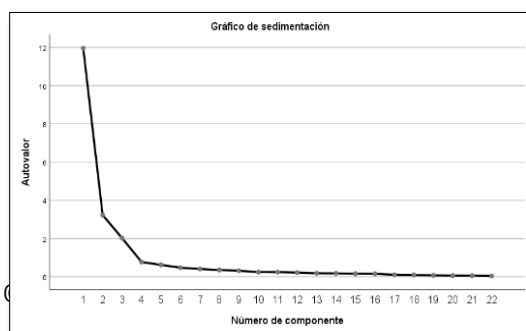


Figure 1

The sedimentation of the items

The results of the rotated component matrix with 5 iterations with values greater than 0.4 detected the rearrangement of the items, observing three components, which are seen in increasing order of the coefficients for each one of them. The first component was called the dynamism subscale, it is made up of 9 items from 1 to 9 (din_1 to din_9), another factor called information acquisition made up of 6 items (adq_10 to adq_15), and the third called Feedback, made up of 7 items (ret_16 to ret_22), of the three components, the latter presents a slight dispersion between the values of items with code (ret) as can be seen in the figure of components in rotated space, while the

Figure2

Components in rotated space

values of the Dynamism component show greater cohesion between them. In addition, the correlations detected between the subscales are: the relationship between dynamism and information acquisition is 0.551**, between dynamism and feedback 0.497** and between information acquisition and feedback is 0.748* *, for all cases there is $p_value < 0.05$ representing significant correlations (Gil-Flores, 2003).

Based on the analysis described and observed in the data in the table and figures, the questionnaire scales are defined by three components with their respective items . The respective coefficients are shown below:

Figure 3

Confirmatory factorial model of the gamification scale questionnaire for university students with correlated measurement errors

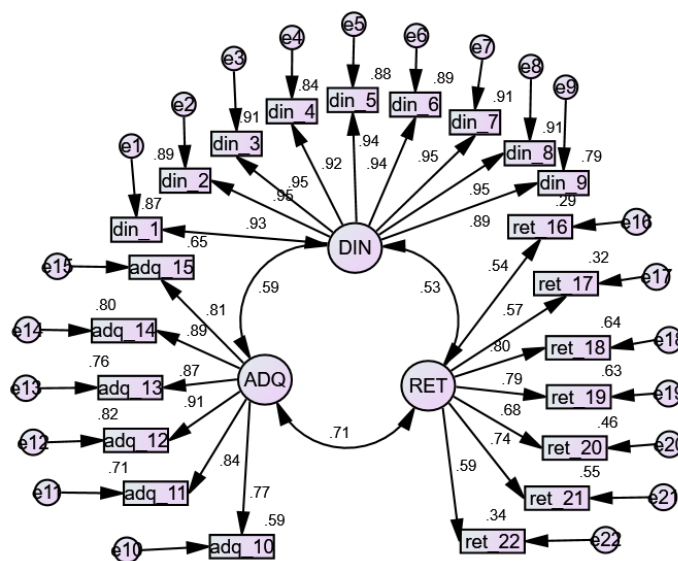


Table 4

Adjustment index of the models of the gamification questionnaire in university students

Absolute Fit		Incremental adjustment				Parsimonious			
Measurements		measure				adjustment measures			
Model	Chi squared	RMSEA	GFI	TLI	NFI	Ratio	AIC	PCFI	PNFI
Statistical	622,357	0.070	0.897	0.884	0.914	0.892	760,357	0.8	0.762

The flowchart, according to Hernández y Pascual (2018), detects the validity of the gamification instrument composed of three dimensions: dynamism (DIM), information acquisition (ADQ) and feedback (RET), which show the factor loads and the coefficients between the components with their respective errors detected by the SPSS_25 and AMOS Software. The adjustment coefficients of the model allow to show the concordance, dependency from different fronts (Alaminos-Chica et al., 2015); the Comparative Fit coefficient Index (Comparative Adjustment Index) CFI = 0.897, represents an adequate parsimonious adjustment coefficient greater than 0.90 (Alaminos-Chica et al., 2015); Likewise, regarding the coefficient of Non Normed fit Index , (Non-normed fit index), TLI = 0.884 represents the fit per degree of freedom of the proposed model and null (Resett y Gámez-Guadix, 2018b); finally, we have the coefficient of Root Mean Square Error of Approximation (root mean square error of approximation) RMSEA = 0.070 (Reivan-Ortiz et al., 2019 y Sierra et al., 2012); These coefficients show that the data fit the model and the items that make up each factor (dimension) of the variable are the most appropriate.

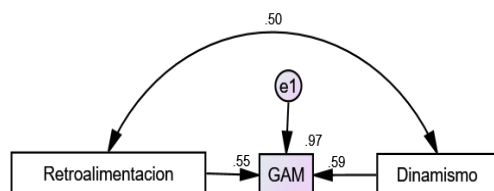
Regarding the coefficient of relationship between the dynamism dimension and the acquisition of information, it is 0.59; however, the item dim_6 and dim_7 with

statement *the interaction with the gamification is entertaining and the gamification, during the class, arouses my learning interest* receives a load of 0.95, which represents the highest levels, while the item, dim_9 , with statement *the teacher shows interest in the use of gamification tools* , presents a load of 0.89 representing the lowest compared to the others. In the information acquisition dimension, the most representative item is adq_12, *I enjoy answering course questions through gamification* , it has a load of 0.91, while item adq_10 , *the knowledge acquired in my study before the synchronous class, facilitates answering gamified questions* have the lowest load of 0.59 compared to the others.

Proceeding to the identification of the relationship between the information acquisition dimension and feedback, it shows a coefficient of 0.710. The item with the highest load and representativeness is ret_17, *receiving virtual recognition during gamification activities, motivates my learning* , which has a load of 0.80, and item ret_16, *rewards for solving course questions, motivates my participation* , has a load of 0.54. and ret_22. *You absolve the errors you had when answering the gamified questions with your teacher* , with a factorial load of 0.59. Finally, the relationship between dynamism and feedback presents a coefficient of 0.53; with p.value < 0.05; p***, in addition, the loads for each item of

the questionnaire present a high level (Meléndez et al., 2009). These arguments described allow us to state that the scale and **structural model**

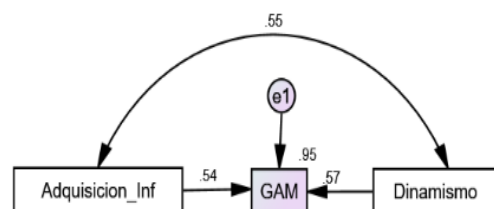
its components show significance to detect the perceptions regarding gamification under the three components described.



El flujo estructural (Alaminos-Chica et al., 2015), muestra el comportamiento de las cargas factoriales de los componentes en relación a la variable. La gamificación (GAM) recibe cargas factoriales de los componentes de la Retroalimentación y Dinamismo: $GAM = 0.59 \text{ Dinamismo} + 0.55 \text{ Retroalimentación}$, los valores emitidos por los componentes a la GAM, lo distribuyen de manera equitativa con una ligera fuerza por el componente del Dinamismo. Los valores de: Chi cuadrado (χ^2) = 3175.66, los coeficientes de bondad de ajuste de GFI y NFI representan 0.899 y 0.91 respectivamente, con un índice de parsimonia RMSEA 0.06.

Figure 4

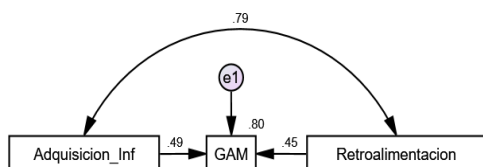
Structural relationship. Feedback and dynamism



La relación estructural, con ecuación de la $GAM = 0.57 \text{ Dinamismo} + 0.54 \text{ Adquisición de la Información}$, en referencia al estadístico $\chi^2 = 2390.62$ y los coeficientes de bondad de ajuste GFI, NFI con 0.801 y 0.901 respectivamente, con un índice de parsimonia RMSEA 0.07, estos datos admiten la validez del modelo, además la carga factorial a la GAM son equitativas con una ventaja muy pequeña del componente Dinamismo.

Figure 5

Structural relationship. Acquisition of information and dynamism



Finalmente, en la relación estructural de la $GAM = 0.49 \text{ Adquisición de la Información} + 0.45 \text{ Retroalimentación}$, quienes determinaron los estadísticos $\chi^2 = 3709.16$, y los coeficientes de bondad GFI, NFI de 0.86 y 0.92 respectivamente, con una índice parsimonia RMSEA 0.07, estos índices permiten la validez de los componentes en función a los ítems.

La comparación entre las cargas factoriales el componente Dinamismo emite ligeramente una carga mayor en comparación a los otros dos.

Figure 6

Structural relationship. Information acquisition and feedback

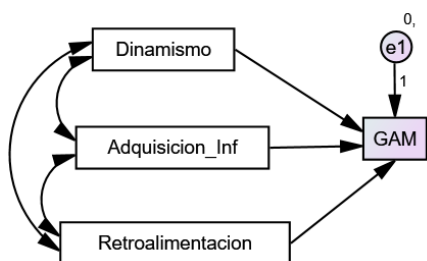


Figure 7

Flow

of the components of the structural equation of the gamification scale

Finally, the flow of gamification is shown with its three measurement scales : dynamics, information acquisition and feedback process, conceived as exogenous components and endogenous to).

Table 5

gamification, this model was developed to determine convergent validity. The model presented an adequate fit $\chi^2 = 13.462$, $p < 0.001$, CFI = 0.91, TLI = 0.94 and RMSEA = 0.07. It was observed that the scores of the Gamification subscale ($p < 0.001$

Components, indicators and items of the gamification questionnaire scale

Components	Indicators	items
Dynamism (DIN)	Motivation	Gamification improves my level of attention
		The use of gamified activities reinforces my learning of the course
		I enjoy learning through gamification.
		The use of gamified activities is appropriate in learning the

		topics of the course.
		Competition through gamification reinforces my learning.
		The interaction with gamification is entertaining.
	Interest	Gamification during class arouses my interest in learning.
		Competition through gamification reinforces my learning.
		The teacher shows interest in the use of gamification tools
		The knowledge acquired in my study before the synchronous class makes it easier to answer the gamified questions .
Information	Commitment	Starting the class synchronously with gamification helps me to be attentive in class.
Acquisition (ADQ)		I show a good predisposition when interacting with gamification.
		I enjoy answering course questions through gamification
	Recognition	The way the course questions are presented is entertaining.
		The rewards for solving the questions in the course motivate my participation.
		I need a stimulus or reward to interact
		Receiving virtual recognition during gamification activities
Feedback (RET)	mechanical	motivates my learning
		The teacher solves the technical problems that arise during the gamification
	Interaction	The skills generated with gamification do not allow my

learning.

You ask the teacher your doubts generated when solving the gamified questions .

At the end of the synchronous class, the teacher solves the gamified questions .

You absolve the errors you had when answering the gamified questions with your teacher.

conclusion

After the results obtained, it is confirmed that the gamification scale for university students is valid and reliable to be used in the academic field; The results show a good level of concordance detected by the Aiken index and high reliability with Cronbach's alpha. The exploratory and confirmatory factor analysis detected three factors: dynamism, information acquisition and feedback with a total explained variance of 78.228%, with their respective factor loads generated by the principal components method, associated with the structural equation diagram. Finally, the questionnaire made up of the measurement scales could be completed with the inclusion of open qualitative questions, allowing a better interpretation of the answers on the attributes of gamification.

Discussion

Gamification is an important element of the teaching and learning process, since it establishes the dynamic and interactive link between students and teachers in order to improve knowledge and skills through teaching materials appropriate to new experiences and expressive forms of communication. digital society (Prieto Andreu, 2020). The gamification

questionnaire (Marín Díaz, 2016) is one of the few instruments considered by university students, who perceived a high level of participation within the curricular experiences that was considered by the AFE sequence. The psychometric contributions of Ramos Vargas (2016) allowed an approximation to the application of the theories, methods and techniques associated with the visible indicators thanks to the behavioral manifestations. The study is based on the analysis of the data to obtain the gamification scales, which allowed the systematization of the three components thanks to the flow of the structural equations.

The study Resett y Gámez-Guadix (2018b) evaluated the psychometric properties of the Cyberbullying questionnaire in university students through exploratory and confirmatory factor analysis, detecting two subscales of Cybervictimization , this allows us to affirm that thanks to the AFE and AFC it is possible to detect the subcomponents of what was similar with the methodological sequence of the study. For their part, Raju et al. (2021) they detected the use of the gamification scale in higher education students, weighing the importance and interest in the use of different tools. Abella

et al. (2014); García-Jurado et al. (2017) y Ortiz-Colón et al. (2018) presented measurement scales, who detected the validity and reliability of the gamification variables in their different tools, such an effect was thanks to the exploratory and confirmatory analysis, who reduced the factors that compose it and verified by the use of structural equation models.

Para Vélez Meza et al. (2020), the emergence of new technologies allowed the use of new ways of directing learning, possibly with the insertion of gamification, which arouses interest and motivation; for his part, Andriani et al. (2019) y they Ortiz-Colón et al. (2018) promoted experiences with experimental methodologies using gamified tools, they also detected the interest in using them and the importance during student learning, who detected a high level of use and the importance during their applicability.

The reliability of the questionnaire presents a sequence that allows detecting similar data regarding the application in other similar scenarios according to Mateus-Galeano y Céspedes-Cuevas (2016); the validity and internal consistency of the instrument "Measurement of perceived self-efficacy in sleep apnea"- SEMSA was detected; For the analysis, there was a sample of 151 patients with sleep apnea hypopnea syndrome, the construct validity, the exploratory factorial analysis determined three factors with a total explained variance of 52.2%; the study under consideration followed the sequence to achieve the purpose but with a larger sample size and with 78.228% of variance explained for three factors (dimensions), a study that corroborates the sequence of Tobón et al. (2018), who support the validity of a rubric for evaluation to the cognitive aspects applied to university students, the validity process was thanks to the factorial analysis sequence that yielded two factors.

Finally, future studies should problematize gamification at different

learning levels to try to detect if the instrument retains its psychometric properties and indices, as well as detect measurement invariance with different age groups, and the use of the questionnaire for independent samples is recommended to factorial reanalysis of the instrument scale, inserting the concepts of item response theory, criterion validity and test-pretest reliability.

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