Llorente-Cejudo
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Relationship and variation of dimensions in gamified experiences associated with the predictive model using GAMEX

Carmen Llorente-Cejudo[1*]

*Correspondence: karen@us.es

[1] Department of Didactics and Educational Organisation, University of Seville, Seville, Spain

Abstract

Gamifying educational practices is a trend in the field of education, especially in universities. Knowing which dimensions are significant in active gamified methodologies allows understanding the extent to which a dimension depends on another if there is a correlation between them. Through the GAMEX (gameful experience in gamification) scale, which measures gamified experiences (Journal of Interactive Marketing, Elsevier 43:98–115, 2018), the aims of this study were to: 1) explore, using the structural equations model, the viability of the GAMEX model formulated to analyse the gamified experience level of university students; and 2) determine the influence of the GAMEX variables on the students' degree of mastery in gamified experiences. The sample was constituted by 405 university students. A structural equation modeling (SEM) analysis was carried from a PLS (partial least squares) approach, using SmartPLS software. The results show the reliability of the different constructs considered in the proposed model. The items presented acceptable reliability levels and strong consistency with the dimensions of the model. The model emphasises the multidimensional character of gamified experience and supports the students' mastery over the different gamified experiences.

Keywords: Gamification, GAMEX, Active methodologies, PLS, Analytical model, Higher education

1 Introduction

In the last few years, gamification has become a popular and recurrent topic in many fields, such as education, marketing and business. Teachers have coined this methodological strategy as a promising way of providing students with positive experiences that pave the road for them to attain the different didactic goals.

Gamifying educational practices is nowadays an increasing tendency; although it employs characteristics aimed at emotions, which are typical of games, this does not imply that learning should be carried out entirely as a game. On the other hand, the aim is to use the elements of gaming in contexts that are not completely ludic, which will allow creating more game-like learning experiences, that is, gamified experiences (Deterding et al., 2011; Huotari & Juho, 2017; Alzahrani & Alhalafawy, 2023). Due to its easy design regarding teaching actions and the results of previous research supporting it (Newman & Gough, 2020; Ramírez et al., 2020; Recabarren et al., 2021; García Lázaro and Sánchez Sánchez, 2022; Llorente et al., 2022), it is clear that gamification was already identified by different experts in education as one of the main pedagogical trends (Deloitte, 2013). However, it is important to understand the effects of gamified experiences on learning, especially game practices, for the adoption of innovation.

To carry out an educational experience based on gaming, it is necessary to involve the students in a task that will probably be unrelated to their past experiences, especially in higher education, where the traditional models lead any type of methodological proposition among the faculty.

1.1 Conceptualising gamification as an experience based on gaming

Understanding the concept of *gamification* implies exploring its construct, as well as the dimensions that partially constitute it, through an extensive review of the existing literature. Thus, and according to Huotari & Hamari (2017, p. 3), "there does not seem to exist a single common definition for gamification or gamified experience" in the scope of gamification itself. Consequently, from an abstract level, it is possible to assume some of its experiential game potentialities, such as the ludic experience, which is carried out and incorporated in a context where users, in this case students, did not expect gaming to appear as an element of their learning. Therefore, gamifying denotes the action in which a strategy unrelated to gaming becomes an application that includes gaming elements (Deci & Ryan, 2000; Deterding et al., 2011; Parra & Segura-Robles, 2019b; Llorente-Cejudo et al., 2022; Martín-Párraga et al., 2022), which implies that all those gaming elements (e.g. a reward, stories, etc.) of a gamified strategy are not necessary for the strategy to comply with its essential functions, whereas a game could not exist without gaming elements.

Thus, it is important to conduct a literature review about games themselves, as this will provide a notion of what gamification can comprise as a gaming experience. In this sense, in a gaming context, the role of positive emotions (enjoyment, amusement, pleasure, etc.) is substantially emphasised (Harwook & Garry, 2015; Lluch-Molins et al., 2022), which is enhanced with the captivating character of those games that involve the pedagogical aspects of participation (immersion, presence, fluidity, etc.) (Brockmyer et al., 2009). Therefore, gamified experience must be considered as a gaming experience in which multidimensional construction is a fundamental requirement, taking into account that it cannot be focused on a single element, and that its aim is to emphasise and identify specific, relevant, emotionally positive and immersive experiences.

Different studies (Poels et al., 2012; Fu et al., 2009; Yang et al., 2017; Alabbasi, 2018; Taesotikul et al., 2021) on emotional gamified experiences have measured the practices of players through the dimensions of pleasure, excitement and mastery, using scales that, based on flow theory, predict the positive emotional experience of the individual from enjoyment, reflecting the interrelated nature of the emotionally positive and immersive characteristics. *Flow* is understood as the "total absorption in a certain activity and its unaware enjoyment" (Hamari & Koivisto, 2014, p. 10), where, in addition, different aspects can be negatively affected, such as self-awareness, focused concentration, and the sense of time, and it can be considered as a specific degree of participation in the game. Other elements that have been highlighted by previous studies as significant are immersion and presence, stating that "immersion involves a lack of sense of time, a loss of awareness of the real world, participation, and the feeling of being in the environment of the task" (Jennett et al., 2008, p. 4), and presence is established in a psychological state in which the virtuality of the experience goes unnoticed (Lee, 2004).

Considering these different research lines, it can be concluded that gamification, with gaming as its central element, is a complex construction, with specific emotional and participatory aspects as subdimensions. Based on this multidimensionality, the aim of the present study was to validate the predictive model known as GAMEX (Eppmann et al., 2018) on one of its main variables ("Mastery") in gamified experiences.

1.2 Significant variables in gamified experiences

To determine, relate and validate those dimensions that are representative of gamified experiences, we used the GAMEX scale, which was developed through a standard procedure (Eppmann et al., 2018) in five steps (generation of a group of elements, reduction of elements, determination of the dimensionality of the scale, scale stability test and scale validity verification) and translated and validated in Spanish by Parra & Segura (2019a). From these works, the dimensions that constitute the scale are specified below:

a) Enjoyment: this dimension implies that enjoyment explains most of the variation of the gamified experience compared to the other five factors. Therefore, the enjoyment of the students can be influenced by motivation, considering that those who enjoy and are motivated in the classroom are also more prepared and learn better.
b) Absorption: it analyses the absorption level of the student that participated in a gamified experience, as well as the degree of abstraction achieved with the latter, taking into account that significant relationships could be established between the absence of negative effect and enjoyment. This fact has already been reported in several studies (De la Fuente et al., 2016), emphasizing the relevance of the different positive emotions associated with constructs of self-regulated learning, performance (attitudinal and procedural) and learning satisfaction.
c) Creative thinking: this dimension is based on a perspective from which students respond to the current educational tendencies through their capacities in relation to experimentation, playing and the arts.
d) Activation: this dimension measures the degree of attention of the students, considering their participation in active methodologies that require their collaboration for the good functioning of the latter.
e) Absence of negative effect: it is important that negative emotional characteristics are absent to ensure the good gaming experience.
f) Mastery: if the students perceive that they master the experience, they would probably feel also active and motivated, thereby enjoying the learning process and acquiring an intrinsic feeling of mastery over the situation that will produce affective mas-

tery. As was stated by Gil & Díaz (2012, p. 8), "teachers must work on and promote among the students the acquisition of intrapersonal and interpersonal skills that influence the management of fear, anxiety, interest, motivation, and even curiosity, enthusiasm and commitment. All this will encourage students to naturally improve in their teaching and learning processes".

Although all variables are significant in learning processes through active methodologies, mastery over gamified experiences results from the acquisition of skills and capabilities that students must have in order to attain the expected outcomes through these learning strategies. The topic of the mastery and competencies of students and teachers has become, in the last few years, a research line that, along with the digitalisation of society, is developing rapidly in all educational stages, from early childhood education to higher education, as is shown by the increase in scientific production in this respect (García-Ruiz et al., 2020; Boté-Vericad et al., 2023).

To participate in this type of experiences, motivation is a sine qua non condition. To attain it, the user must have a certain degree of freedom to decide her/his actions and, in a game, players have such freedom to choose which tasks they will carry out, although based on their skills, personal preferences, and mastery of the context.

The aim of the present study was to explore the possible relationships among the different variables of the GAMEX (gameful experience in gamification) questionnaire, analysing the dimensions between them and with student mastery, which will be crucial for identifying and analysing how gamified experiences are developed, taking into account their prediction with creative thinking, enjoyment of the experience, absence of negative effect, feeling of abstraction and absorption.

2 Materials and methods

2.1 Objectives

The objectives of the present study were to:

a) Determine, through structural equation modeling (SEM), the viability of the GAMEX model formulated to analyse the gamified experience level of university students.
b) Explore the influence of the GAMEX variables on the degree of mastery in gamified experiences.

2.2 Participants

A total of 405 university students from the Bachelor's Degree in Primary Education, with a greater percentage of women (f = 344, 84.9%) and an average age of 20 years, were recruited using a non-probabilistic convenience sample.

From the total sample, it is worth mentioning that most of the students worked with a gamified methodology in the classroom (f = 303, 74.8%).

2.3 Instrument

As was pointed out in previous sections, the scale used was GAMEX. This scale was developed and validated in English by Eppmann et al. (2018). The response options are based on a Likert scale, where 1 indicates "*totally disagree*" and 5 indicates "*totally agree*". The scale has 6 main dimensions that evaluate the experience of the participants in gamified activities or environments: Enjoyment (6 items), Absorption (6 items), Critical thinking (4 items), Activation (4 items), Absence of negative effect (3 items), and Mastery (4 items).

The GAMEX scale has previously demonstrated its reliability as an instrument to gather information about gamified experiences (Eppmann et al., 2018). The mentioned authors obtained very high internal consistency indices, with Cronbach's alpha values above 0.90 for each of the dimensions and for the total scale.

In the present study, we used the version of GAMEX adapted to the Spanish context (Parra-González and Segura-Robles, 2019a). The mentioned authors carried out, on the one hand, an exploratory factor analysis (EFA), and, on the other hand, a confirmatory factor analysis (CFA), with the aim of confirming the dimensional structure of the scale. The results reveal the complexity of evaluating gamified experiences from a single and valid perspective, as different dimension are involved. In the discussion, this paper emphasises the multidimensional character of the gamified experience, and it highlights the need to develop a model to evaluate and improve future experiences with similar characteristics.

3 Results

Structural analysis models are gaining popularity in social research, due to their capacity to generate knowledge about both manifest and latent variables. These models allow effectively combining both types of variables.

In the analysis of SEM, two main methodologies are usually employed: those based on covariances and the PLS (partial least squares) approach. In this study, the latter was used, as it does not require the assumption of multivariate normality in the observations. It is important to mention that the PLS approach was implemented using SmartPLS software, and the standard analytical phases in this type of research were followed (Samperio, 2019).

Firstly, the Cronbach's alpha coefficient was applied to evaluate the reliability of the different constructs considered in the proposed model (Table 1).

According to different authors (O'Dwyer & Bernauer, 2014), since these values are above 0.7, it can be asserted that all obtained levels are adequate.

Table 1 Cronbach's alpha of the different latent variables considered

Dimension	Cronbach's alpha
Absorption	0.930
Activation	0.736
Absence of negative effect	0.877
Amusement	0.785
Mastery	0.772
Creative thinking	0.897

Table 2 Simple loadings or correlations of the indicators with their respective construct

	ABS	ACT	ANE	AMU	MAS	CRE THI
A1				0.617		
A2				0.704		
A3				0.826		
A4				0.832		
A5				0.694		
A6				0.461		
B1	0.829					
B2	0.877					
B3	0.819					
B4	0.912					
B5	0.888					
B6	0.826					
C1						0,885
C2						0,887
C3						0,854
C4						0,865
D1		0.714				
D2		0.546				
D3		0.664				
D4		0.817				
E1			-0.867			
E2			-0.872			
E3			-0.409			
F1					0.598	
F2					0.729	
F3					0.545	
F4					0.841	

ABS Absorption, *ACT* Activation, *ANE* Absence of negative effect, *MAS* Mastery, *CRE THI* Creative thinking

Table 3 Composite reliability

Dimension	Composite reliability
Absorption	0.945
Activation	0.761
Absence of negative effect	-0.759
Amusement	0.820
Mastery	0.821
Creative thinking	0.911

With regard to the simple loadings or correlations of the indicators with their respective constructs, Table 2 shows the different values obtained. It is important to take into account that, in order to consider that an indicator belongs to a construct, it must have a loading close to 0.6.

It can be observed that all values have a loading close to 0.6. Therefore, no element was removed during the process.

Table 4 Average Variance Extracted (AVE)

Dimension	Average variance extracted (AVE)
Absorption	0.739
Activation	0.749
Absence of negative effect	0.660
Amusement	0.791
Mastery	0.773
Creative thinking	0.762

Table 5 Fornell-Larcker criterion

	ABS	ACT	ANE	AMU	MAS	CRE THI
Absorption	0.859					
Activation	0.387	0.692				
Absence of negative effect	-0.156	-0.266	0.748			
Amusement	0.301	0.133	-0.265	0.7		
Mastery	0.411	0.317	-0.112	0.296	0.688	
Creative thinking	0.556	0.502	-0.259	0.566	0.476	0.873

ABS Absorption, *ACT* Activation, *ANE* Absence of negative effect, *MAS* Mastery, *CRE THI* Creative thinking

The next step involved analysing the composite reliability, which is related to the internal consistency of the set of indicators that evaluate the latent variables. This value allows determining whether each indicator is measuring the same aspects and, thus, whether the latent variable is considered to be adequately represented. The minimum value to be considered well fitted is 0.7. The results are presented in Table 3.

Simultaneously, we calculated the convergent validity, which determines whether a set of indicators represents a single underlying construct. To this end, the average variance extracted (AVE) was used. The value obtained in the AVE was used to assess the fit of the model, which was required to be above 0.5, indicating that more than 50% of the variances of the construct are due to the indicators (Bagozzi & Yi, 1988). The results are detailed in Table 4.

To calculate the discriminant validity, which allows determining whether each construct established is significantly different from the rest, two approaches were applied: Fornell-Larcker criterion (Table 5) and factor crossed-loadings (Table 6).

Fornell-Larcker criterion is based on the fact that the AVE of a construct must be greater than the variance shared by that construct with the rest of the constructs in the model. Moreover, the correlations between the constructs must be weaker (in absolute value) than the square root of the AVE. The simplest way of verifying this is by analysing the values in the main diagonal, which correspond to the square root of the AVE, ensuring that these are higher than the values outside of the diagonal, which represent the correlations between constructs.

Next, the crossed-loadings analysis was performed, which determines whether the different items included in a construct actually measure aspects of said construct. To this end, it is necessary to obtain a value that indicates that the loading is greater in its corresponding construct than in the others.

Table 6 Cross-loadings matrix

	ABS	ACT	ANE	AMU	MAS	CRE THI
A1	0.135	0.044	-0.078	0.617	0.156	0.286
A2	0.215	0.057	-0.252	0.704	0.153	0.367
A3	0.36	0.087	-0.191	0.826	0.287	0.462
A4	0.236	0.091	-0.26	0.832	0.24	0.445
A5	0.14	0.084	-0.279	0.694	0.15	0.386
A6	0.083	0.188	-0.056	0.461	0.192	0.382
B1	0.829	0.202	-0.034	0.217	0.225	0.338
B2	0.877	0.209	-0.186	0.193	0.307	0.359
B3	0.819	0.424	-0.223	0.283	0.372	0.632
B4	0.912	0.343	-0.023	0.308	0.398	0.554
B5	0.888	0.341	-0.144	0.237	0.303	0.441
B6	0.826	0.395	-0.167	0.277	0.43	0.455
C1	0.479	0.42	-0.251	0.494	0.477	0.885
C2	0.521	0.378	-0.285	0.56	0.432	0.887
C3	0.457	0.47	-0.271	0.459	0.312	0.854
C4	0.479	0.503	-0.102	0.454	0.41	0.865
D1	0.264	0.714	-0.33	0.143	0.251	0.48
D2	0.1	0.546	-0.015	-0.151	0.145	0.064
D3	0.243	0.664	-0.079	0.093	0.211	0.364
D4	0.405	0.817	-0.234	0.188	0.251	0.385
E1	0.11	0.166	-0.867	0.285	0.066	0.21
E2	0.12	0.19	-0.872	0.354	0.056	0.34
E3	0.01	-0.031	-0.409	0.331	-0.047	0.22
F1	0.118	0.102	0.021	0.082	0.598	0.179
F2	0.175	0.267	-0.034	0.24	0.729	0.248
F3	0.085	0.106	0.058	0.103	0.545	0.224
F4	0.501	0.3	-0.189	0.288	0.841	0.499

ABS Absorption, *ACT* Activation, *ANE* Absence of negative effect, *MAS* Mastery, *CRE THI* Creative thinking

The analyses conducted up to this point allow concluding that the items included in the questionnaire show acceptable levels of reliability and present a strong consistency with the dimensions in which they are located in the model. Next, the formulated structural model was analysed, through standardised regression coefficients (path coefficients) and the values of Student's t-test and R^2 (R-squared). These data provide information about the percentage of variance of the constructs that is explained by the predictor variables, allowing us to evaluate the viability of the designed model (Fig. 1).

The obtained results indicate that 26.6% of the variance of the latent variable "Mastery" is explained by 9.7% of the variable "Activation", 19.8% by "Absorption", 7.1% by "Enjoyment", 28.7% by "Creative thinking" and 3.8% by "Absence of negative effect". Regarding the predictor variables, all of them presented significant correlations with the three levels of competencies, with "Creative thinking" being the most influential competence.

To determine whether the obtained scores were significant, Student's t-test was applied for the path values, using the Bootstrap technique. The results are detailed in Table 7.

The obtained results indicate that the correlations with the main dimensions of the model are significant. Lastly, to evaluate the goodness of fit of the structural model, the SRMR

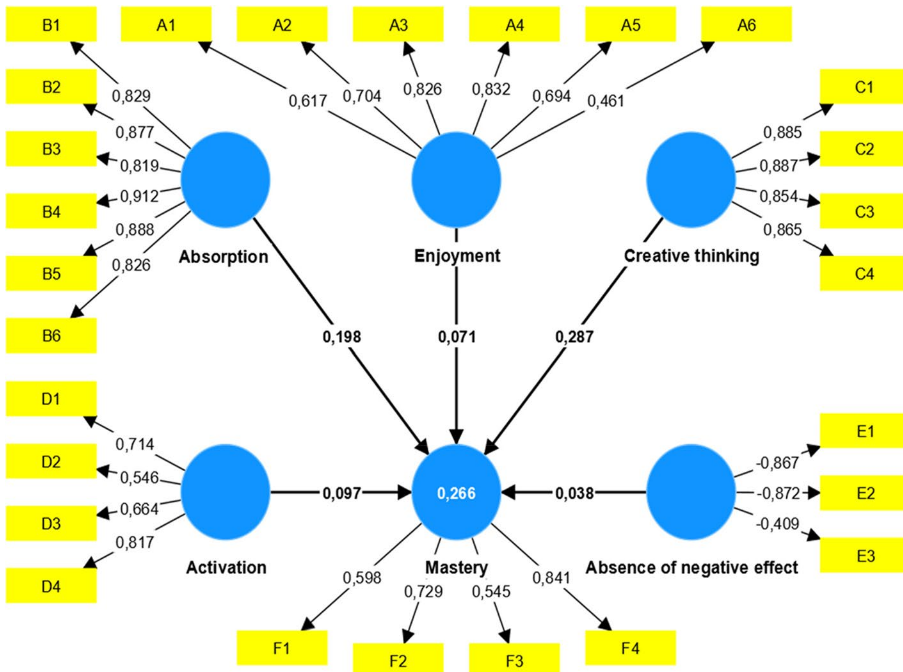

Fig. 1 GAMEX model

Table 7 Standardised regression coefficients (path coefficients)

Predictor variable	Dependent variable	Path coefficient
Absorption	Mastery	0.201
Activation	Mastery	0.397
Absence of negative effect	Mastery	0.797
Amusement	Mastery	0.511
Creative thinking	Mastery	0.033

(standardised root mean square residual) indicator was used, which generated a value of 0.056. This value is lower than 0.08, which indicates a good fit of the model.

4 Discussion and conclusions

It is obvious that gamification is a strategy that uses gaming elements in contexts that are unrelated to gaming with the aim of developing ludic and emotionally positive experiences, although there is no formula establishing the exact measure to analyse the gaming experience (Huotari & Hamari, 2017). However, the analysis of the viability of the GAMEX model provides indicators to generate further knowledge on gaming experience, considering its demonstrated reliability and validity (Aranda Romo & Caldera Montes, 2018; Olugbara & Letseka, 2020).

Nowadays, it is essential to have reference models for measuring the participation of students when active methodologies are incorporated, especially gamified experiences, in the teaching and learning processes. This would allow identifying, analysing and thoroughly understanding the dimensions that contribute to developing adequate mastery, by both students and teachers, incorporating gamification in the classrooms, which requires the existence of solid and strongly interrelated scientific evidence (Anderson & Maninger, 2007; Arcila-Calderón et al., 2015).

The validity of the SEM, regarding the analysis of the models, shows the different contributions of each of the constructs, as well as the influence of their items. It also allows evaluating the entire construct, and not only the contributions of each dimension on the model. Thus, as is indicated by its increased use, this technique is acquiring great reach in educational research (Martínez-Ávila and Fierro-Moreno, 2018; Samperio, 2019; Bas-Peña et al., 2020).

It is worth highlighting that the first objective of this study was to explore, through the structural equations model, the viability of the GAMEX model formulated to analyse the gamified experience level of university students. The latter is consolidated, since the obtained results show the robustness of the theoretical model sustained by the model developed for understanding the "Mastery" dimension, according to the proposition of GAMEX. Therefore, all the obtained data reinforce the fact that the sample size was much larger than that recommended for this type of SEM study (Vargas and Mora-Esquivel, 2017).

The above mentioned contributes to the attainment of the second objective of this work, i.e. to analyse the significance of the variables of GAMEX on the degree of mastery in gamified experiences, highlighting that the model supports and emphasises the idea that student mastery over the different gamified experiences influences the other dimensions more strongly and significantly than the variable itself on the rest of variables. In this sense, it is a relevant and novel idea, considering that few studies have thoroughly analysed the dimensions that affect, influence or determine the degree of success of a gamified experience. In this regard, the main results of this study show that there is a direct and significant effect between the five analysed dimensions of the GAMEX model and student mastery. It was found that the dimensions with greater impact on mastery were Absorption (0.097) and Activation (0.198). Consequently, understanding the level of absorption and abstraction of the student could be a good predictive indicator of his/her mastery over the gamified experience. The same goes for understanding the degree of attention of the student with this methodology, as it may influence his/her degree of mastery. However, other dimensions of the model, such as enjoyment, creative thinking and the absence of negative effect, did not have a great impact on the dimension of mastery.

This study paves the road for future research lines, such as the observation of other possible latent dimensions that may influence gamified experiences, including creative thinking and the degree of absorption of the student in the experience, pedagogical training and tutor experience (Roa González et al., 2022), and context of development or specialty in which the gamified experience is incorporated (Trinidad et al., 2021).

If, from the scope of research, we offer a representative model that allows defining dimensions regarding the realisation of gamified experiences, as well as establishing the criteria that can be adopted to analyse the needs of the students for the incorporation of active methodologies in the classroom, we will provide a type of "know-how" that can determine, from planning, the real needs that must be contemplated in this type of learning situation.

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Author's contributions
C.L.C. developed the theoretical foundation and methodological framework, carried out the analyses, established the results and drew the conclusions of this study.

Declarations

Competing interests
The authors declare that they have no competing interests.

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