Ángel Salvatierra Melgar, Carlos Augusto Luy-Montejo, Segundo Sigifredo Pérez Saavedra, Abraham Ermitanio Huaman Almiron, Quispe-Cutipa Walter Arturo, Celia Emperatriz Mercado-Marrufo. (2021). Gamification in the Learning of Mathematics in University Students. *International Journal of Early Childhood Special Education (INT-JECSE),* 13(2): 444-454. DOI: 10.9756/INT-JECSE/V13I2.211081

Received: 02.05.2021 Accepted: 02.08.2021

Ángel Salvatierra Melgar[1]
Carlos Augusto Luy-Montejo[2]
Segundo Sigifredo Pérez Saavedra[3]
Abraham Ermitanio Huaman Almiron[4]
Quispe-Cutipa Walter Arturo[5]
Celia Emperatriz Mercado-Marrufo[6]

Gamification in the Learning of Mathematics in University Students

Abstract

In the framework of continuous improvement of university education, the corresponding bodies are attentive to the good practices detached by the agents that comprise them. In this study, gamification in the mathematics learning process is described from the perspective of 286 students identified by non-probabilistic intentional sampling. Under these arguments, the methodology of the study is non-experimental, descriptive ex-post-facto level; the data for the analysis were collected in two stages: first moment in an instantaneous way to be able to perceive directly the gamification in the learning of mathematics through the Mentimenter tool; in second moment, the questionnaire was applied with 33 items composed of three dimensions: dynamics, mechanics and component from the contributions of Kevin Werbach. The results attributed to the study show that gamification, from the student's perspective, is a dynamic tool for the learning of previous concepts of Basic Mathematics and Mathematical Complements in the first academic semesters; in addition, the teacher plays the role of facilitator and the student responsibly manages his space and learning environment.

Keywords: Gamification, Learning, Mathematics, University Students.

Introduction

The governing body of the National Superintendence of University Higher Education (Sunedu) implemented eight Basic Quality Conditions (CBC), in this way, demonstrate minimum standards for the operation and provide educational services in the Universities of Peru (Sunedu, 2018); in this regard, responding to condition IV of component IV.2 referring to research processes and educational services for the improvement of student learning, teachers, from the classroom, promote new educational practices within the current scenarios of social isolation; teachers play a primary role in attracting the attention of students during virtual classes, even more so when it comes to the teaching of mathematics (Sanchez, 2020). Today we are called upon to review the

Ángel Salvatierra Melgar[1], Universidad Nacional Mayor De San Marcos, Peru.
Email: asalvatierram@unmsm.edu.pe; ORCID 0000-0003-2817-630X
Carlos Augusto Luy-Montejo[2], Universidad Privada Del Norte, Peru.
Email: fracarlitos@gmail.com; ORCID ID: 0000-0003-0824-7959
Segundo Sigifredo Pérez Saavedra[3], Universidad César Vallejo, Peru.
Email: sperezs@ucv.edu.pe; https://orcid.org/0000-0002-2366-6724
Abraham Ermitanio Huaman Almiron[4], Universidad Nacional De Ucayali, Peru.
Email: abraham_huaman@unu.edu.pe; https://orcid.org/0000-0002-5813-8059
Quispe-Cutipa Walter Arturo[5], Universidad Nacional Intercultural De La Amazonia, Peru.
Email: wquispec@unia.edu.pe; ORCID: https://orcid.org/0000-0001-9355-1984
Celia Emperatriz Mercado-Marrufo[6], Universidad Cesar Vallejo, Peru.
Email: cmercado@ucv.edu.pe; https://orcid.org/0000-0002-4187-106X

ways of teaching, session planning, curricular plans, career plans. Likewise, teaching strategies, learning styles, the assertiveness and precariousness of the different educational institutions have highlighted the worldwide pandemic. The University, concerned about learning and teaching in these scenarios, has been planning and developing the insertion of gamification actions within the sequence of class sessions in order to pay and activate the attention of the mathematical content in this context of ubiquitous learning (Novoa et al., 2020); ubiquitous learning allows teaching-learning in a personalized way in any space and time to the extent that one can have a computing device such as a computer, tablet, laptop or a mobile device associated with the Internet.

For Vanegas and Giménez (2021), the practice of mathematics allows negotiating the meaning of its concepts under the standard of describing and interpreting interactive processes during the resolution of cognitive conflicts. The positions described above respond to the emerging educational model of connectivism (Siemens et al., 2005) from the bases of psycho-pedagogy; active networked learning is proper and exclusive to those who learn in a critical way for their integration in a collective, making use of social networks for the construction of knowledge individuals allowing the insertion to social groups and interact according to their needs and participatory interests. For Sanchez et al. (2019) and Salvatierra et al., (2021), within educational scenarios, the use of technology becomes important throughout the educational process for its usefulness, versatility of use for each stage of learning and teaching at various educational levels from educational games in networks, construction of prototypes, simulators, use of models for simulations, search for information of high scientificity in different databases.

The learning of mathematics, in isolation contexts, is manifested as the change from an approach focused on content to one focused on the development of academic skills assisted by computers, allowing the student to adapt to challenging challenges such as the use of data search strategies, systematization of literary content, the use of digital calculators, graphic simulators among other tools of Web 2. 0 tools, becoming a mediator of their learning according to their own pace, which translates into a constructivist approach based on experimentation and reflection to activate the student's attention and awakens the student's interest, the insertion of educational games energizes the student's interaction with the thematic content becoming a vital process of learning translated into gamification.

For Flores and Uribe (2021), gamification is manifested as the achievement of objectives through the game; this activity is reflected in the classroom as a technique in the digital society, allowing the student to obtain results through the achievement of challenges, acquired rewards and personal growth through visibility among the participants of the group. Gamification is understood as a creative technique with substantial advantages in student learning, evidencing the acquisition of skills such as the use of netiquette, interaction with the computer, behavioral regulation, spontaneous participation, self-acceptance, visibility of their achievements, among others. Gamification within learning allows the link between the student and the better understanding of knowledge or the development of skills to understand the complexity of the tasks (Flores and Uribe, 2021).

According to Ortiz et al. (2018), in the educational context, gamification are playful and interactive processes for learning in different subjects that allow promoting attitudes and behaviors among students in a collaborative manner and autonomous study; in this regard, Parra et al. (2020) refer that the game is part of life in a natural context; it is also used, in education, as a spontaneous and natural tool in educational environments to promote learning. The obtaining and awarding of points, levels or avatars, the time of dedication of the students, is increased to the level of involvement in the execution of activities. The gamified activity increases the psychological predisposition in the student to remain in an active state, thanks to the use of information and communication technologies allows this activity within the teaching and learning process.

For Aguilar and Ramos (2016), student motivation is caused by gamification for reading and writing in five stages: analysis, gamification, formalization, mediation and packaging of the university student. Villalustre and Del Moral (2015) adopted, in their pedagogical practice, simulated games from collaborative digital tools, manifesting the use and game mechanics, which allow motivational learning and satisfaction that enhances the acquisition and development of competencies. Marín (2015) annexes connectivity and student engagement through educational gamification in order to improve the learning process based on the use of the game; video games in teaching-learning facilitates cohesion, integration, motivation by the dynamizing content allowing the creativity of individuals.

Educational gamification links the concepts of the curriculum in the sequentializing process of learning (Borrego et al., 2017); gamification enables the learning of university engineering students during interaction and academic activities. For López et al. (2019), it is advisable

to create effective educational escape rooms during session schedules (Cerda et al., 2017); mathematics, as a curricular experience at the university level, is developed at different levels; the curriculum considers relevant the learning of this discipline; in such academic process, multiple factors intervene such as the academic training of the teacher, level of security on the subject, the didactics of the teacher, the level of autonomy of teaching work, cultural level of the parents, school climate, access to communication, use of technological tools, level of intrinsic and extrinsic motivation, among others.

The perpetuity of teaching and learning strategies in some university institutions associated with bad practices that affect the purposes in the achievement of mathematics leads to the loss of meaning for students and the decontextualization of topics far from their reality. A great number of students consider that learning mathematics is limited to memorization based on linear processes, to the schematization of the book, reducing it to a memorized and passive learning of calculation. Under this traditionalist concept, biased and removed from contemporary scenarios, students have migrated towards environments and the use of computational tools facilitating feedback, interaction and self-evaluation for cooperative work as a strategy for knowledge construction.

Mathematics and games inserted into learning, according to Eguia et al. (2015), allow the development of skills in the student, encouraging collaborative and participatory learning; in this regard, Holguin et al. (2020) point out that, after the systematic review, gamification can affect academic performance provided that the applications are designed under cognitive parameters accompanied by the teacher. From this perspective, there are tools that are frequently used by the teacher to create short questions such as Quizizz, Flipquiz and Kahoot, where the student answers from a computer or mobile device. The Padlet to create walls as if it were a collaborative whiteboard with simultaneous participation on a questioning given by the teacher or the one who directs.

Gamification, as part of the learning of mathematics within the context of pedagogically mediated games, implements a scoring system, badges, rankings, levels, among others, according to achievements; this generates a dynamic of competition, exploration, collection, among others, awakening a high level of motivation, intellectual curiosity, recognition by whoever directs with cognitive stimulation of achievements of resolution of exercises by levels.

Ruiz (2019) comments that, in 2015, the quizizz was implemented as a game within academic activities; this quiz game allows us to customize and create our own quizzes or exams in a fun, playful and interactive way (Rodríguez et al., 2019). In recent years, the use of online resources to formulate multiple-choice questions, related to educational gamification, has increased. The quizizz is a gamification tool with free and open access, which encourages teachers to interact with virtual resources; in this way, collaborative learning and student motivation during the learning process are allowed. For the organization of the questions, the teacher decides the time and order of each question; each student controls his/her time and performs the activities in a calm, reflective and individual way. At the end of the contest, the student can detect the successes and failures, identify the time spent for each of the questions, level position against the other competitors, and receive virtual stimuli. Game-based or gamified learning in higher education contributes to the development of mathematical competencies and skills as basic and fundamental aspects, which will allow promoting and consolidating the initial concepts.

In reference to the manifestation in previous lines, the practice of quizizz represents a tool for gamification; from the teacher's practice, it represents an innovative view of interaction with technology in favor of the learning of the thematic contents of the curricular experience implemented as innovative teaching practices. In this regard, Naffah et al. (2016) present an open perspective on the development of educational games, which prioritize the challenge related to their development and effective potential in the classroom as open educational resources for the student. Hernández et al. (2016) refer to the existence of different gamification elements that can be applied to academic work.

The learning of mathematics associated with gamification releases attitudes, emotions and interest towards learning (Romero and López, 2021; Cadavid and Gómez, 2015); it is clear the lack of mathematics knowledge in higher level students when dealing with precalculus which are preliminary concepts to higher mathematics; the use of virtual gamified tools is a good alternative to improve academic performance and reduce student dropout in academic semesters (Zabala et al., 2020); game-based learning in the teaching of higher mathematics has generated remarkable changes, allowing to capture the student's attention and promote cognitive learning strategies, in addition to reinforcing emotionally, soft and behavioral skills.

Material and Method

The study was developed in university students of public and private modalities enrolled in the subject of Basic Mathematics or

Mathematics Complements; the selection of students responds to the criteria of sufficiency and representativeness who issued their perceptions about gamification in the learning of mathematics. From the scope of the methodology, the study is non-experimental, since the variables are not manipulated, with an ex-post-facto descriptive model (Rodríguez et al., 2017); the information was collected in the natural context where the student makes use of gamification tools spontaneously. The idea shared in the research has focused on the consideration concerning gamification in the scenario of learning mathematics, allowing us the insertion during the teaching learning process favoring the interaction between students, in addition the academic objectives and the improvement of student-teacher relationships were achieved. In this sense, the objective of the study was to describe and analyze the perceptions of gamification in mathematics learning from the university student's perspective.

In order to identify the perception of gamification, a survey was made through the mentimenter tool to the question "What is your opinion of gamification?", the answers obtained allowed to identify the role of interactive actions planned by teachers during learning sessions; then the perceptions were collected from the technique of a questionnaire previously validated by judges with recognized experience in educational technology, obtaining the content validity verified by the Aiken technique. The instrument developed and validated was called Questionnaire of perception of gamification in the learning of Mathematics, with 33 items distributed in three components from the contributions of Kevin Werbach taken from Tobon et al. (2020), who attribute the production of educational materials based on the logic of video games with a focus on gamification of learning that implies a learning model based on situations with greater human-machine interactivity. In this regard, Ortiz et al. (2018) and Area Moreira and González (2015) attributed the three components and indicators on which the study was launched.

Dynamics made up of 8 items that detect the restrictions or rules for the game, the emotions that flow during the interactivity, the stories during the participation, the progression of levels detecting the successes and failures in the act of playing the game. Mechanics conformed by 12 items committed to the student's challenges during the participation, the competitions among group mates with the intention of winning or reaching the best levels, associated to rewards with visibility for the participants who managed to place themselves among the first places, becoming creators of crowns, avatars, among others, awakening personal egos and personal egos, among others, Components made up of 9 items that allow to show the levels of achievement, in addition the participant selects the character for identification during the game, assuming the levels of achievement in situations of complexity facing exercises and problems from lower to higher grade while getting it right and positioned in a new record.

Results

The perception of gamification, the quizizz by the students, the results are shown simultaneously in real time to the question attached through the mentimeter tool (Martinez, 2019); the answers obtained are shown in the word cloud detected by its simple and participatory form in real time with each participant answers (it was limited to 1 words as an answer for each student); while the answers are recorded and the frequencies of words detected, assume various sizes and colors depending on the answers issued.

Figure 1.

Frequencies of perception of gamification

The results is the report of the mentimenter on the perception of the questioning visible in the figure that allowed standardizing the answers given by the students (n=286), this tool is based on the Delphi method that allows the standard construction in consensus with those who interact (Muse et al., 2020).

The simplicity of using the tool allowed for a very impactful report in an instantaneous manner that fixes attention on size, location and colors. The results with more frequency and size are positioned in the center differentiating colors. In reference to the image, they state that gamification is fun for learning; it is due to the fact that the student participates spontaneously with the games inserted in the contents treated in class; this activity allows paying attention during the explanation of the subject in a virtual way, this is associated to the acquisition of information allowing him to interact while learning. The fun is translated to the predisposition to understand, to understand the meaning of the concept for a meaningful learning, associating to the dynamic component in the generation of emotions during the interaction.

The other frequent term detected is practicality; it is based on its ease of manipulation and access to the game for interaction in the resolution of questions with alternative answers associated with sounds, competition, prizes, visibility of achievements by the members during the interaction inserted to the competitiveness to obtain avatars, crowns, cards, among others, allowing to strengthen the ego and strengthening learning. The learning of mathematics is made interesting by the insertion of interactive tools inserted sounds, the interface of the presentation board during the competition. The student discovers the practical usefulness of mathematics, who is the source of motivation that will soon constitute the basis for the performance of subjects for their professional training. Under the described positions to the instantaneous answers detected by the described tool, the perceptions are associated to the questions of the questionnaire composed of three components. With respect to the Dynamics composed of eight items, the active detachment of the student in front of the gamification is evidenced, obeying the rules of the gamification associated to the assertiveness, in the figure.

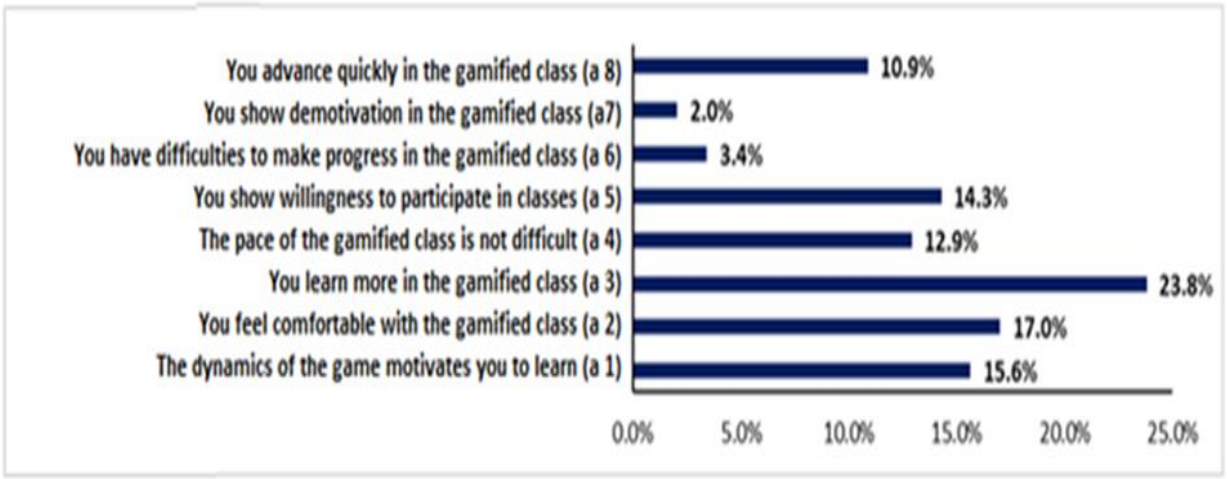

Figure 2.

Percentage frequency of the dynamic component of gamification

The results indicate the restrictions inherent to the rules of the game, as in the case of the item "you advance quickly in the branched class. The 10.9% of the students surveyed, predispose that the interactive activities are indicated for a certain moment; but it does not allow exploring other questions since it is biased for the end of some moment of the class; however, a low percentage of 2% of students are unmotivated; upon inquiry, they stated that these games are not adapted to the university level and it is limited for learning and they were inhibited in participating, we could assume that they do not know the benefits of the tool. On the other hand, in the indicator of emotions, 23.8% of the participants present good disposition for the study so they learn more during the gamification sessions, demonstrating proactivity and managing to connect their previous learning, associating to the item referring to the pleasure of interacting, 17% show joy generating a good predisposition to access the questions and face challenges at different levels of difficulty, appreciated in the result of 14.3%.

The dynamics of learning mathematics in gamified classes is relevant, since the student accesses previous concepts associated with different levels; in this regard, 12.9% of respondents stated that learning mathematics does not show difficulty in answering questions, moreover it is advantageous because it awakens interest and the euro to face new situations; therefore, to new fun experiences, generating intrinsic motivation to answer and access visible answers, this description was expressed by 15.6% of students. Finally, regarding the progression indicator, 3.4% of the respondents perceive that, thanks to the gamification inserted into the mathematical concepts, students advance and progress at different levels, acquiring rewards such as cards, avatar, positions on the board, and visibility of achievements by the other competitors.

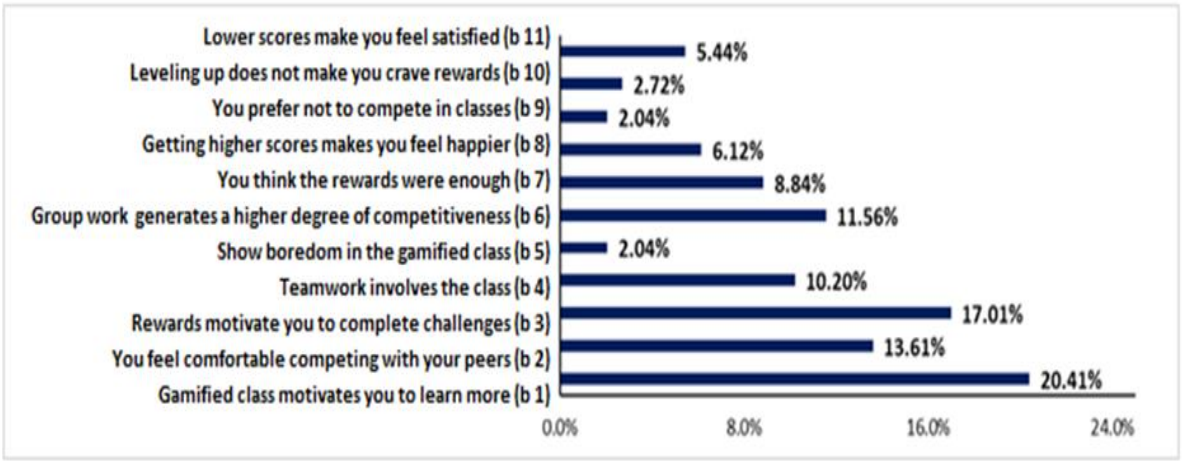

Figure 3.

Percentage frequency of the mechanical component of gamification

However, 5.44% of the gamification participants do not feel satisfied or do not show interest in taking on a learning challenge, in addition to this, 2.04% do not prefer to compete and show their achievements in the learning sessions, which would allow 2.04% of the participants to generate boredom the act of competing, playing, showing their achievements and blunders spontaneously during the learning process.

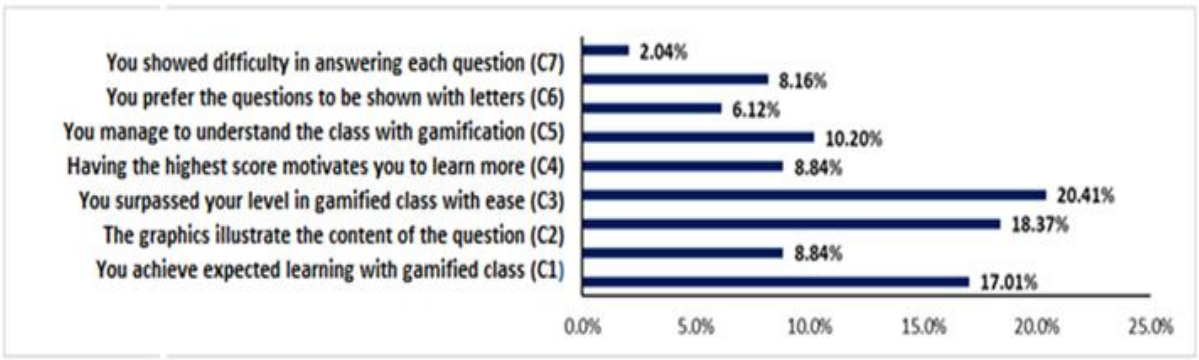

Figure 4.

Percentage frequency of the gamification component

The results of the table allow us to evidence the percentage frequencies of the items of the progression indicator issued by the students during the interaction in the learning of mathematics; in this regard, 20.41% of the students show predisposition to learn more than expected since the exercises are of short and closed answers; the interaction and the characteristics of the games motivate the development of competences and skills, of them, 13. 61% of the respondents present predisposition to compete among their peers feeling confident to take on challenges and challenges; these arguments corroborate the 17.01% of the students who are motivated during the interaction with the questions related to the

topics of the subject interacting, frequently observing their achievements and order location in the interface.

11.56% of the students present predisposition to compete in gamification, this is due to the interaction that by nature show these tools associated with sounds, score assignment, positioning in simultaneous comparison with their peers acquiring rewards such as 8. 84% of the students show representativeness to this act for being part of the learning process, representing the main indicator of the rewards; in addition, students show interest in being named by the teacher as winners in each event, showing the ego of being mentioned and visible by the other participants by being creditors of honorable mentions in a visible way and manifested by the teacher. In this process of recognition, the student acquires a strong motivation and, consequently, feels committed for their next participations leading to attention, promoting autonomous learning, viewing slides and other learning materials hosted on the platform and others as in the case of the Khan Academy (Salvatierra Melgar et al., 2021).

Finally, in the gamification component dimension, the winner's status indicator shows a considerable percentage since 20.41% of the student's state that, by obtaining high scores in gamification, they feel motivated to learn and be more competent in their next contests, allowing the ease of learning the branched class as shown by 18.37% of the students. In addition, 17.01% of those observed consolidate their learning through gamification and expect to reach the expected level. Possibly, they are those students who achieved a good interaction with gamification, achieving adequate levels in the acquisition of mathematical contents to solve their questions and doubts regarding the thematic contents.

The perception of the way of presenting the questions associated with figures shows a good acceptance of fixation during problem solving, since it generates attention and adequate visibility; in this regard, 8.84% of the students show representativeness to the questions through icons; however, 10.20% of the students show interest in the questions with literal statements. Finally, regarding the achievement levels indicator, in the tool interface, the scores are shown spontaneously to the success or failure of the questioning associated to the time spent for each question and, at the end of the game, the participants are able to show the general location, showing in descending order the names of each participant; the first places are made to creator of cards, avatar, virtual rewards with visibility for all members of the group.

Table 1.

Goodness of fit to the items of the dynamic component of gamification

	a1	*a2*	*a3*	*a4*	*a5*	*a6*	*a7*	*a8*			
Dinamic	28.79	34.01	66.7	19.65	24	1.36	0.49	13.9			
	$X_c^2 = 41.9\ X^2_{(1-0.05;7)} = 14.07$										
	b1	*b2*	*b3*	*b4*	*b5*	*b6*	*b7*	*b8*	*b9*	*b10*	*b11*
Mechanic	54.55	24.2	37.88	13.6	0.55	17.52	10.2	4.91	0.55	0.97	3.88
	$X_c^2 = 61.56\ X^2_{(1-0.05;10)} = 18.307$										
	c1	*c2*	*c3*	*c4*	*c5*	*c6*	*c7*	*c8*	*c9*		
Component	38.27	10.4	44.63	55.1	10.35	13.78	4.96	8.82	0.55		
	$X_c^2 = 31.81\ X^2_{(1-0.05;7)} = 15.507$										

The goodness-of-fit test (Mahdizadeh and Zamanzade, 2019) shows that the questionnaire items are associated with and dependent on the dynamic, mechanical and component dimensions, as detected by the Chi-square statistic; in this regard, in the dynamic dimension, the comparison of X_c^2>X_((1-0. 05;7))^2 (41.9>14.07), likewise, for the mechanical dimension X_c^2>X_((1-0.05;10))^2 (61.56>18. 307) and in the component dimension al del X_c^2>X_((1-0.05;8))^2 (31.81>15.507); these results allow us to affirm that the arguments described above obey each of the components in reference and the differentiated existence of the results between the items, in addition the actions of gamification during the process of learning mathematics by the student respond to the items of each dimension.

Discussion

The emergent educational model of connectivism (Siemens et al., 2005) is the basis of the psychopedagogy of those who learn in a personalized way physically; but massified within the virtual environment; the study is based on this principle, since the student from his physical location participates in a personal way in front of a group of his peers visible virtually; in this circumstance of social isolation, interactivity has shown great importance in the learning process from different scenarios (AlKhaza'leh and Obeidat, 2021). Gamification translated into the insertion of games for learning mathematics. For their part, Flores and Uribe (2021) state that the achievement of learning through the game allows the student to interact with the questioning of mathematics topics exposed by the teacher (Ortiz-Colón et al., 2018; Relaiza, et al., 2021). Gamification is an interactive tool that supports learning adaptable to various topics and applicable at all educational levels; in addition, it has been possible to observe volitional aspects such as empathy, thus, the manifesto of the winners enunciate that..... the next one, you will win the contest, now it is my turn...., these reactions are very frequent, demonstrating to be part during the contests and their visibility in the levels achieved.

The game is part of life (Parra et al., 2020), in a natural context, such as learning in educational environments associated with virtual scenarios generating expectations and motivation (Aguilar and Ramos, 2016) in a range of open and unlimited information (Villalustre and Del Moral, 2015); social simulations games allow collaborative learning and promotes the development of skills such as interactivity, how to respond in front of the ordered when addressing listeners, respect in front of their peers, accepting the rules of the game, among others (Marín, 2015). Connectivity and educational gamification potentiate the learning process based on the game, facilitating cohesion, integration, linking concepts and questioning in the learning of mathematics; in this regard, Borrego et al. (2017) indicate that gamification allows learning in conjunction with academic activities, (López et al., 2019); students promote their academic achievements in an ascending way, evidencing the levels and positioning during interactivity.

For Cerda et al. (2017), academic achievement, in the mathematics curricular experience, is influenced by multiple factors, gamification inserted in the mathematical content allows to contribute one of the many factors for learning in an interactive way (González, 2000); calculations are addressed in a concrete and immediate way to access the answers associated with images, sounds, displacement of silhouettes in the interface and the distractors inserted in the competition; in this regard, Eguia et al. (2015) state that gamification allows the development of interactive skills. For Holguin et al. (2020), they contribute to the detachment of cognitive processes in the company of the teacher (Ruiz, 2019). The quiz game allows personalization in order to identify levels of achievement in the various problems and exercises applied during the sequence of the learning session. By its nature, this action awakens interest by engaging participation. The arguments of Rodriguez et al. (2019), on the use of technology in educational institutions, have allowed adapting to the processes of evaluation and resolution of exercises and problems to be treated virtually by the students, making use of platforms. During gamification actions, one of the tools of open access and interactive, attractive and easy to use is the quizizz, which shows a set of short questions with closed answers, by its form of interaction and colorful interface associated with distractors arouses motivation to face the questions; for Naffah et al. (2016), it is an open perspective to the games associated with learning virtually.

Learning mathematics associated with gamification allows motivating and awakening interest (Romero and López, 2021), since they relate conceptual aspects and game interaction strategies; for Cadavid and Gómez (2015), learning precalculus in a virtual gamified environment leads to improved academic performance; according to Zabala et al. (2020), game-based learning generates notable changes in cognitive, emotional and soft skills development as evidenced by the indicators during the study.

Universities, permanently, seek and encourage new educational practices within the current scenarios of social isolation; under these circumstances (Figallo et al., 2020), 56% of the licensed universities started online teaching, after a few months of the beginning of the pandemic, incurring to the use of tools with specialized platforms and many of them with free access platforms, facing these academic practices they are discovering and promoting the use of different tools, without having previously discovered their usefulness, functionality of use that possibly many of these activities will last during the academic activities when returning to face-to-face (Vértiz, et al., 2020).

Conclusion

Gamification, from the student's perspective, is a dynamic tool for the learning of the previous concepts of the contents of Basic Mathematics and Mathematical Complements in university students in the first academic semesters. In these virtual scenarios, the

teacher plays the role of facilitator in terms of access to information and monitoring during the actions of gamification within the virtual tools; however, the student acquires and learns in a ubiquitous way when he/she shows attention, concentration and motivation within the use of information technology linked to mathematical contents, demonstrating skills and abilities to responsibly manage his/her learning space and environment.

References

Aguilar, A., & Ramos, A. (2016). Implementing a gamification methodology to motivate reading and writing in young university students. *Kepes*, *13*(14), 61-81.

AlKhaza'leh, M., & Obeidat, B. (2021). Students' Preferred Professors: The Human and Educational Aspects. *International Journal of Early Childhood Special Education*, *13*(1), 28-34. https://doi.org/10.9756/INT-JECSE/V13I1.211004

Area, M., & González, C. (2015). From teaching with textbooks to learning in gamified online spaces. *Educatio Siglo XXI*, *33*(3), 15-38. https://doi.org/10.6018/j/240791

Borrego, C., Fernández, C., Blanes, I., & Robles, S. (2017). Room escape at class: Escape games activities to facilitate the motivation and learning in computer science. *Journal of Technology and Science Education*, *7*(2), 162-171. https://doi.org/10.3926/jotse.247

Cadavid, J., & Gómez, L. (2015). Use of a gamified virtual learning environment as a didactic strategy in a pre-calculus course: A case study at the National University of Colombia. *RISTI - Revista Iberica de Sistemas e Tecnologias de Informacao*, *16*, 1-16.

Cerda, G., Pérez, C., Casas, J., & Ortega, R. (2017). Teaching and Learning Mathematics: The need for a multidisciplinary analysis. *Psychology, Society, & Education*, *9*(1), 1-10. https://doi.org/10.25115/psye.v9i1.428

Eguia, J., Contreras, R., & Solano, L. (2015). Digital games from the teachers' point of view. A didactic experience in Catalan primary classrooms. *Teoría de la Educación. Educación y Cultura en la Sociedad de la Información*, *16*(2), 31-48.

Figallo, F., González, M., & Diestra, V. (2020). Peru: Higher Education in the Context of the COVID-19 Pandemic. *Revista de Educación Superior en América Latina*, *8*, 20-28.

Flores, D., & Uribe, A. (2021). The Gamification in the Development of Information Literacy from the Perspective of University Students Abstract. *Interam. Bibliot*, *44*(2). https://doi.org/10.17533/udea.rib.v44n2e342687

González, R. (2000). Factors influencing the mathematical performance of early college students. *Persona*, 11-26. https://doi.org/10.26439/persona2000.n003.804

Hernández, L., Muñoz, M., Mejia, J., & Peña, A. (2016). Gamification in software engineering teamworks: A systematic literature review. *Applications in Software Engineering - Proceedings of the 5th International Conference on Software Process Improvement, CIMPS 2016*, *2017-Janua*, 1-8. https://doi.org/10.1109/cimps.2016.7802799

Holguin, F., Holguin, E., & García, N. (2020). Gamification in mathematics education: a systematic review. *Telos*, *22*(1), 62-75. https://doi.org/10.36390/telos221.05

López, S., Gordillo, A., Barra, E., & Quemada, J. (2019). Examining the Use of an Educational Escape Room for Teaching Programming in a Higher Education Setting. *IEEE Access*, *7*, 31723-31737. https://doi.org/10.1109/ACCESS.2019.2902976

Mahdizadeh, M., & Zamanzade, E. (2019). Goodness-of-fit testing for the Cauchy distribution with application to financial modeling. *Journal of King Saud University - Science*, *31*(4), 1167-1174. https://doi.org/10.1016/j.jksus.2019.01.015

Marín, V. (2015). Educative gamification. An alternative to creative learning | La Gamificación educativa. Una alternativa para la enseñanza creativa. *Digital Education Review*, *27*.

Martínez, N. (2019). Real-time classroom surveys. *Educational technology observatory, 9*, 1-8.

Muse, L., Frazer, J., & Fidler, E. (2020). The IEEE P2784 Standardization Process Workshop: The use of Delphi method and interactive evaluation tools to identify perceptions about Smart Cities. *2020 IEEE International Smart Cities Conference, ISC2 2020*. https://doi.org/10.1109/ISC251055.2020.9239067

Naffah, S., Arias, A., Hernández, J., & Ortega, C. (2016). Student perceptions about the use of new technologies in higher education institutions in Medellin. *Revista Lasallista de Investigacion*, *13*(2), 151-162. https://doi.org/10.22507/rli.v13n2a14

Novoa, F., Cancino, R., Uribe, Y., Garro, L., & Mendez, G. (2020). Ubiquitous learning in the teaching-learning process. *Revista Multiensayos. Universidad San Ignacio de Loyola*, 2-8.

Ortiz-Colón, A., Jordán, J., & Agredal, M. (2018). Gamification in education: an overview on the state of the art. *Educação e Pesquisa*, *44*, 1-17. https://doi.org/10.1590/s1678-4634201844173773

Parra-González, M., Segura-Robles, A., Cano, E., & López-Meneses, E. (2020). Gamification to improve student activation in learning. *Texto Livre*, *13*(3), 278-293. https://doi.org/10.35699/1983-3652.2020.25846

Relaiza, H., Fuster-Guillen, D., Ocana-Fernandez, Y., Aparicio, P., & Tataje, F. (2021). Cognitive Processes and Creative Lateral Thinking in Students of the Naval School of Peru. *NeuroQuantology, 19*(5), 10-17. https://doi.org/10.14704/nq.2021.19.5.nq21043

Rodríguez, D., Mezquita, J., & Vallecillo, A. (2019). Innovative methodology based on educational gamification: Multiple-choice test evaluation with Quizizz tool. Metodología innovadora basada en la gamificación educativa: Evaluación tipo test con la herramienta Quizizz. *Profesorado*, *23*(3), 363-387. https://doi.org/10.30827/profesorado.v23i3.11232

Rodríguez, M., López, A., & Martín, I. (2017). Perceptions of Students in Science of Education on Social Networks Such As Teaching Methodology. *Pixel-Bit-Revista De Medios Y Educacion*, *50*, 77-93.

Romero, M., & López, M. (2021). Lights, shadows and challenges of teachers around ICT-supported gamification: a study with trainee teachers. *Revista Electrónica Interuniversitaria de Formación del Profesorado*, *24*(2), 167-179. https://doi.org/10.6018/reifop.470991

Ruiz, D. (2019). *Quizizz in the classroom: evaluating while playing - INTEF*.

Salvatierra, A., Romero, S., & Shardin, L. (2021). Khan Academy: Strengthening undergraduate students' learning of Calculus I. *Propositos y Representaciones*, *9*(1).

Salvatierra, A., Vértiz-Osores, J., Vértiz, R., Santa María, H., Acevedo, J., Quispe, V., & Rengifo, R. (2021). DevOps as a culture of interaction and deployment in an insurance company. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12*(4), 1701-1708. https://doi.org/10.17762/turcomat.v12i4.1429

Sánchez, G. (2020). Mathematics in the times of the Coronavirus. *Educacion Matematica*, *32*(1), 7-10. https://doi.org/10.24844/EM3201.01

Sánchez, R., Costa, O., Mañoso, L., Novillo, M., & Peracho, F. (2019). Origins of connectivism as a new paradigm of learning in the digital era. *Educación y Humanismo*, *1*(0124-2121), 113-136.

Siemens, G., Onderwijsdagen, S., Age, D., Design, E., Downes, S., & Verhagen, P. (2005). Connectivism : a new learning theory ? *Journal of Instructional Technology and Distance Learning*, *2*(1), 1-5.

Sunedu. (2018). *Basic Quality Conditions.*

Tobon, S., Ruiz, J., & García, J. (2020). Gamification and online consumer decisions: Is the game over? *Decision Support Systems*, *128*, 113167. https://doi.org/10.1016/j.dss.2019.113167

Vanegas, Y., & Giménez, J. (2021). Democratic mathematical practices: Analysis of a school experience. *Avances de Investigación en Educación Matemática*, *19*, 71-85.

Vértiz, J., Cucho, R., Vértiz, R., Vílchez, G., & Angulo, A. (2020). Virtual university education in the context of the health emergency due to COVID-19: Challenges in the evaluation processes. *International Journal of Early Childhood Special Education, 12*(1), 467-477. https://doi.org/10.9756/INT-JECSE/V12I1.201027

Villalustre Martinez, L., & Del Moral Perez, M.E. (2015). Gamitication: Strategies to optimize learning process and the acquisition of skills in university contexts. *Digital Education Review*, (27), 21-39.

Zabala, S., Ardila, D., García, L., & Benito, B. (2020). Game-based learning (GBL) applied to the teaching of mathematics in higher education. A systematic review of the literature. *Formacion Universitaria*, *13*(1), 13-26. https://doi.org/10.4067/S0718-50062020000100013

De La Riva, S., & Ryan, T.G. (2015). Effect of self-regulating behaviour on young children's academic success. *International Journal of Early Childhood Special Education, 7*(1), 69-96.