



Application of Virtual Reality and Gamification in the Teaching of Art History

Evelyn Marilyn Riveros Huaman^(✉),
Roni Guillermo Apaza Aceituno, and Olha Sharhorodska

Department of Systems Engineering,
Universidad Nacional de San Agustín de Arequipa,
Santa Catalina 117, Arequipa, Peru
lynemriver@gmail.com,
roni.guillermo.apaza.aceituno@alumni.usp.br,
osharhorodska@unsa.edu.pe

Abstract. The virtual reality (VR) presents a breakthrough in the field of education and others, because it allows you to interact with a fictional world created through the technology. Users can navigate in real time with a subjective perspective of what is there and can be deployed in this three-dimensional world (3D). We use a virtual learning environment (VLE) done in the Unity3D program where you will simulate a virtual museum to enhance the teaching of history of Art. For which we use predefined stages to improve knowledge in an interactive way through gamification techniques testing was conducted on 15 students in higher education, achieving a more active learning.

Keywords: Virtual reality · Education · Virtual learning environment · History of art · Gamification

1 Introduction

In recent years the museums are being one of the areas where it has been seen more inquiries on virtual reality (VR). This technology allows to transport visitors to different parts of the world allowing recreate the spaces virtually without the need to be present in them, avoiding costs without having to travel.

Virtual reality environments offer us a great flexibility and adaptability in many training opportunities in education. For the creation of the virtual learning environment (VLE) was used Unity3D because it allows you to develop environments of virtual reality (VR), this paper proposes the implementation of a virtual reality game using gamification by elements of video games to improve the teaching of Art History; where will simulate a virtual museum, with predefined stages that expose works from different artistic currents with their respective representations all owing interact with the characters, objects, animations and sounds presented in the application.

The game will allow your users to interact with the virtual environment achieving immersion and interaction with it, allowing students to improve their learning in

History of Art through Gamification techniques used in the game. The rest of this article is organized as follows. Section 2 “Related works”, they provide an overview of related jobs. Section 3 “User elicitation study”, describes the methods in the proposal. Section 4 “Results”, illustrates the results of the experiment. Finally, the Sect. 5 “Conclusions”, concludes this article.

2 Related Works

This investigation is related to the topics: (1) Virtual Reality, (2) Gamification, (3) Virtual Museums. In the field of virtual reality and gamification we find the Gamification study [1] which proposes a game using virtual reality, where they meet the principles of gamification achieving motivate collaborative learning in students of engineering, leading them to work in a team.

In another study [2] undertaken aspects related to the development of applications of Virtual Reality (VR) and Augmented Reality (AR) such as education resources in the teaching of students.

Another form of virtual reality that we find [3] are presented in different cases: the National Archaeological Museum of Marche in Ancona and the 3D reconstruction of the Roman Forum of Fanum Fortunae that are digitized photographs with the technique-structure for the movement metrics and are integrated within the virtual surrounds pace using a PC with a HTC Live system, allowing the user to interact with the 3D models, integrating the virtual reality.

We could find applications that use virtual reality in Museums [4] Samsung gear VR shows us a free application where recreates the city of Gyeongju in South Korea.

Another application that we find [5] shows us a virtual museum next to the colleson of Rijksmuseum, Amsterdam, which contains a virtual art gallery with which the user can interact.

3 User Elicitation Study

In order to find out which interactions are achieved with the application on the students; we carried out a study where a training was carried out for students in the implementation and use.

In which students were able to interact with the application deployed and interacting with objects that are in it, to finally show the scores at the end of the tour by the chambers.

The scores obtained by students will vary according as they come to finish the tour of all the chambers and the interaction achieved. The Fig. 1 shows the different rooms of Paintings presented by the application.

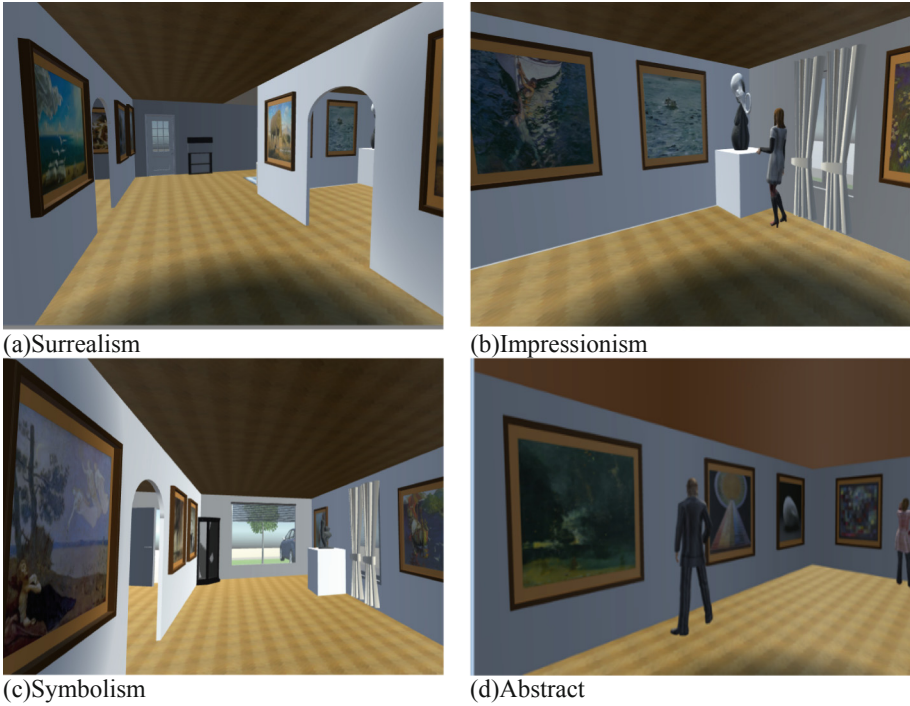


Fig. 1. This figure shows the different rooms of Paintings with their artistic current. (Source: own elaboration)

3.1 Purposal and Participants

In the proposal involved 15 students between the ages of 17 to 22 years among men and women, of the top-level of the Painting are with the support of the master of specialization. All of them have had for the most part a of both gaming experience of virtual reality and other types.

Table 1. Results of the age of respondent (Source: own elaboration)

		Frequency	Percentage	Valid percentage	Percentage cumulative
Valid	17–19	11	73,3	73,3	73,3
	20–22	4	26,7	26,7	100,0
	Total	15	100,0	100,0	

It can be seen in (Table 1) that the largest number of students are among the ages of 17 and 19 years with 73.3% and the least amount between the ages of 20 and 22% in 26.67.

Table 2. Results of the sex of the respondent (Source: own elaboration)

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	1	9	60,0	60,0	60,0
	2	6	40,0	40,0	100,0
	Total	15	100,0	100,0	

In (Table 2), we can see that the majority of the students surveyed represent 60% of “men”, while 40% are women.

Our prototype was based on the virtual reality that was carried out in Unity3D to be used in the computer having as main functionality: support in learning the course on the history of art in an interactive way.

3.2 Chambers, Procedure and Interaction

We asked the students to experiment with the virtual learning environment presented in the proposal to carry out the interaction with the game. We identified 5 rooms where 4 paintings with its main representations and the fifth chamber exposes representative sculptures from different authors. The Fig. 2 shows the Room of Sculptures.

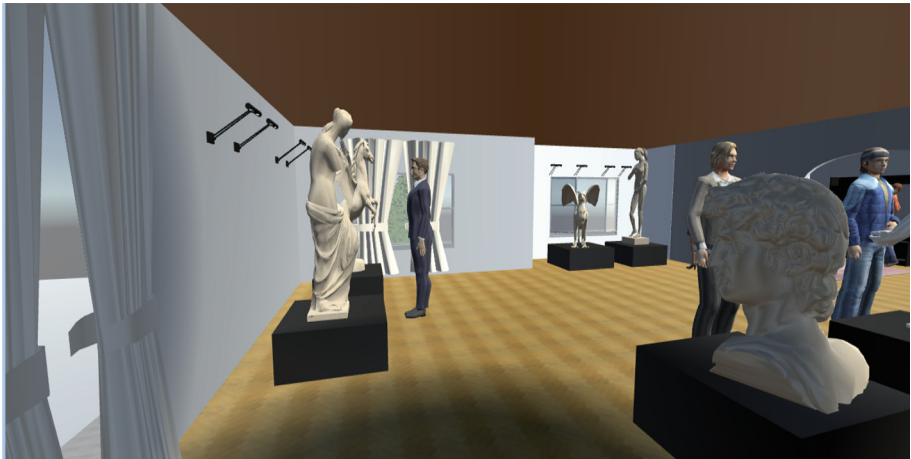


Fig. 2. This figure shows the room of sculpture where representations of several authors are exhibited. (Source: own elaboration)

Before the experiment the students had a brief description of the Characteristics of the app and its possibilities of interaction to achieve. The proposal was used in the interactive simulation because it allows you to achieve a simulation where recreates a virtual world that exists only in your computer. Noting that this simulation is interactive is what distinguishes the reality of an animation.

4 Results

4.1 Measurements and Analysis

To evaluate approaches were applied in the 2 questionnaires: The usability in virtual reality [6, 7], and the virtual learning environment [7, 8], where the following criteria were applied.

Table 3. Criteria for the evaluation of the usability of Virtual Reality (Source: own elaboration)

No	Criteria
1	Level of realism in the virtual environment
2	Level of realism to perform the tasks
3	Freedom of movement in the virtual environment
4	Response time on the screen
5	Level of perception of the virtual environment
6	Visualization and realism in the application
7	Level of navigation and guidance
8	Ease of entry and exit in the virtual environment
9	Easy use of the app
10	Organized tasks and understandable
11	Feeling of being present in the virtual world

Table 4. Criteria for the evaluation of Virtual Learning Environment (Source: own elaboration)

No	Criteria
1	Immersion in the application
2	Learningbecause of realism in the application
3	Easy manipulation of objects in the virtual environment
4	Educational Utility
5	Ease of use of the application
6	Sense of Belongingin the virtual environment
7	Motivation in learning
8	Intention to use the application
9	Cognitive Benefits
10	Effectiveness of the application in learning
11	Satisfaction when using the application

4.2 Results of the Assessment of the Instrument

For which we used the Cronbach’s Alpha [9] to determine the effectiveness of the used instrument.

Table 5. Results of the Cronbach's alpha test (Source: own elaboration)

Cronbach's Alpha	Alpha coefficient based on standardized elements	Number of items
0,753	0,753	11

As can be seen in (Table 5), the Cronbach's Alpha is 0,753 (75.3%), which is located in acceptable, for good. This indicates that the internal consistency of the items analyzed is good.

4.3 Results of Statistics of the Element

The (Tables 6 and 7), shows the results for variables with their respective Arithmetic mean (average), the standard deviation.

With the data presented it is possible that you can calculate the Coefficient of Variation whose formula is: 0 do not vary, further away vary.

$$C.V. = \text{Standard Deviation}/\text{Media} \quad (1)$$

Value that allows us to measure the variation between the two variables is based on the average is 0 because there is no variation.

Table 6. Statistics of the element usability of virtual reality (Source: own elaboration)

Criteria	Media	Standard deviation	N	CV
Environment	3,8	0,561	15	0,148
Task	4	0,535	15	0,134
Movement	3,87	0,64	15	0,165
Time	3,87	0,743	15	0,192
Realism	4,13	0,64	15	0,155
Perception	3,67	0,488	15	0,133
Navegation	3,8	0,561	15	0,148
Ease	3,87	0,743	15	0,192
Application	4,2	0,414	15	0,099
Organization	3,47	0,64	15	0,184
Presence	3,93	0,458	15	0,117

It can be seen in (Table 6), the Coefficient of Variation (CV) measures the percentage of variation. The Level of variation between 0,099 is good approaches zero - 20% is well. As shown in Fig. 3.

It can be seen in (Table 7), the Coefficient of Variation (CV) present the Level of variation between 0, 12 is good, as shown in Fig. 4.

Table 7. Statistics element-based virtual learning environment (Source: own elaboration)

Criteria	Media	Standard Deviation	N	CV
Immersion	1,87	0,64	15	0,34
Learning	2,13	0,35	15	0,17
Easy	2,27	0,59	15	0,26
Utility	1,67	0,72	15	0,43
Ease	1,93	0,80	15	0,41
Sense	1,93	0,70	15	0,36
Motivation	1,87	0,35	15	0,19
Intention	1,93	0,46	15	0,24
Cognitive benefits	1,80	0,56	15	0,31
Effectiveness	1,93	0,59	15	0,31
Satisfaction	2,07	0,26	15	0,12

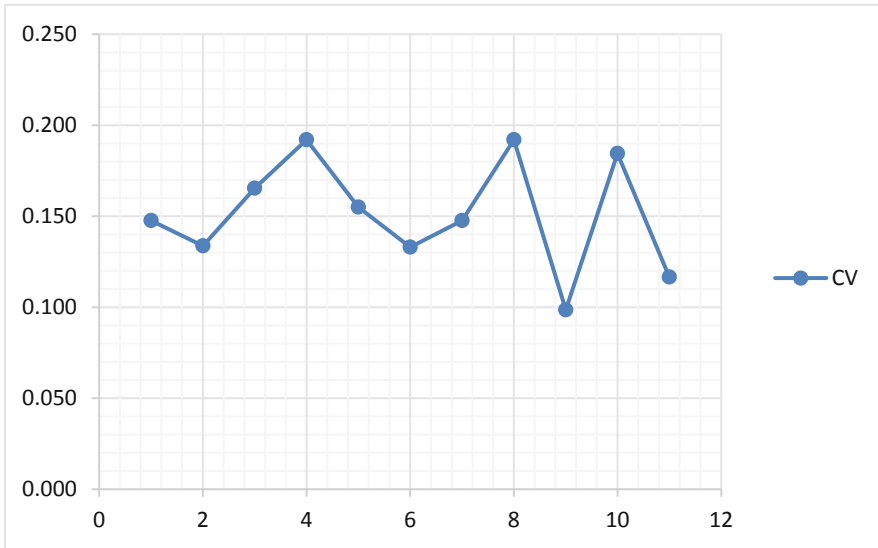


Fig. 3. Coefficient of Variation-Usability of Virtual Reality (Source: own elaboration)

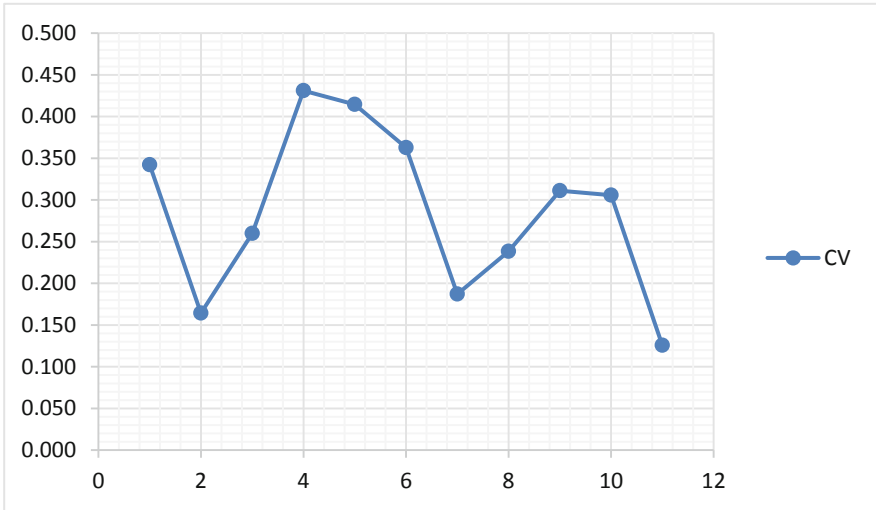


Fig. 4. Coefficient of variation- virtual learning environment (Source: own elaboration)

4.4 Results Correlation Between Elements

From the surveys carried out we determined the correlations among their elements: We find in (Table 8), of the Correlation between elements of Usability of Virtual Reality that the cells marked indicate that there is a good correlation of data between these variables in particular. With 0,715 tasks with navigation and navigation with movement with a 0,717, which are the most related.

Table 8. Correlation between elements usability of virtual reality (Source: own elaboration)

	Environment	Task	Movement	Time	Realism	Perception	Navigation	Ease	Application	Organization	Presence
Environment	1,000	0,477	0,319	0,103	0,478	0,261	0,318	0,446	0,185	0,080	-0,056
Task	0,477	1,000	0,626	0,539	0,209	0,274	0,715	0,360	0,323	0,000	0,000
Movement	0,319	0,626	1,000	0,561	0,221	-0,152	0,717	0,410	0,377	-0,360	-0,033
Time	0,103	0,539	0,561	1,000	0,491	0,066	0,446	0,224	0,325	-0,010	-0,028
Realism	0,478	0,209	0,221	0,491	1,000	0,152	0,080	0,190	-0,108	-0,163	0,033
Perception	0,261	0,274	-0,152	0,066	0,152	1,000	0,261	0,066	0,354	0,305	-0,426
Navigation	0,318	0,715	0,717	0,446	0,080	0,261	1,000	0,274	0,492	-0,119	-0,056
Ease	0,446	0,360	0,410	0,224	0,190	0,066	0,274	1,000	0,557	0,140	0,392
Application	0,185	0,323	0,377	0,325	-0,108	0,354	0,492	0,557	1,000	0,431	0,075
Organization	0,080	0,000	-0,360	-0,010	-0,163	0,305	-0,119	0,140	0,431	1,000	0,114
Presence	-0,056	0,000	-0,033	-0,028	0,033	-0,426	-0,056	0,392	0,075	0,114	1,000

It can be seen in (Table 9), of the Correlation between elements of the Virtual Learning Environment, that there is no a variable that protrudes from the other, it means, there is no significant correlation between variables, we can emphasize.

Table 9. Correlation between elements of the virtual learning environment (Source: own elaboration)

	Immersion	Realism	Manipulation	Utility	Ease	Belonging	Motivation	Intention	Benefits	Effectiveness	Satisfaction
Immersion	1,00	0,40	0,10	0,05	-0,02	0,14	-0,40	-0,28	0,12	-0,03	0,06
Realism	0,40	1,00	0,16	0,19	0,54	0,33	0,15	0,06	-0,22	0,05	-0,10
Manipulation	0,10	0,16	1,00	0,39	0,19	0,05	0,18	0,07	-0,04	-0,15	-0,12
Utility	0,05	0,19	0,39	1,00	0,70	-0,05	0,09	-0,29	-0,35	0,11	-0,25
Ease	-0,02	0,54	0,19	0,70	1,00	0,37	0,22	-0,01	-0,35	0,14	0,02
Belonging	0,14	0,33	0,05	-0,05	0,37	1,00	-0,04	-0,01	0,14	0,16	0,42
Motivation	-0,40	0,15	0,18	0,09	0,22	-0,04	1,00	0,38	-0,14	0,30	0,10
Intention	-0,28	0,06	0,07	-0,29	-0,01	-0,01	0,38	1,00	0,22	-0,02	0,04
Benefits	0,12	-0,22	-0,04	-0,35	-0,35	0,14	-0,14	0,22	1,00	-0,26	0,10
Effectiveness	-0,03	0,05	-0,15	0,11	0,14	0,16	0,30	-0,02	-0,26	1,00	0,50
Satisfaction	0,06	-0,10	-0,12	-0,25	0,02	0,42	0,10	0,04	0,10	0,50	1,00

5 Conclusions

5.1 Conclusions

- Tests conducted in the art students determined that there was good interaction with the proposed educational application although presented certain difficulties which were overcome.
- The results obtained in the correlation between elements of Usability of Virtual Reality of the cells indicate that there is a good correlation of the data highlighting the tasks with navigation with 0,715 and navigation with movement with a 0,717.
- The results obtained in the correlation between elements of evaluation of the Virtual Learning Environment indicated, that here there is no a variable that protrudes from the other, it means, there is no significant correlation between varies.
- We found several advantages in the use of this educational application that improved the learning the course of Art History motivating students although there were also some disadvantages more than everything in the application

5.2 Future Work

It is proposed to add new rooms with current artists where they can make their own virtual exhibitions, as well as integrate technology of augmented reality to improve interaction

Acknowledgement. The present investigation is part of the project “Implementacion de un Laboratorio virtual inmersivo de Astronomía usando Tecnicas de “Gamification” dirigido a Alumnos de Secundaria” BA-0026-2017-UNSA, thanks to the financing granted by the Universidad Nacional de San Agustín de Arequipa.

References

1. Gasca-Hurtado, G.P., Peña, A., Gómez-Álvarez, M.C., Plascencia-Osuna, Ó.A., Calvo-Manzano, J.A.: Realidad virtual como buena práctica para trabajo en equipo con estudiantes de ingeniería. *Revista Ibérica de Sistemas y Tecnologías de Información*, No. 16, pp. 76–91 (2015)
2. Díaz, J.; Fava, L., Banchoff, C., Schiavoni, A., Martin, S.: Juegos serios y aplicaciones interactivas usando realidad aumentada y realidad virtual. In: *XX Workshop de Investigadores en Ciencias de la Computación*, pp. 829–834 (2018)
3. Clini, P., Ruggeri, L., Angeloni, R., Sassob, M.: Interactive immersive virtual museum: digital documentation for virtual interaction. In: *ISPRS TC II Mid-term Symposium Towards Photogrammetry 2020*, pp. 251–257 (2018)
4. Gyeongju vr Museum. <https://www.oculus.com/experiences/gear-vr/844232452316302/>. Accessed 24 Oct 2018
5. VRmuseum.nl. <http://vrmuseum.nl/>. Accessed 24 Oct 2018
6. Sutcliffe, A., Brian, G.: Heuristic evaluation of virtual reality applications. *Interact. Comput.* **16**, 831–849 (2004)
7. Aguirre, R., Nicole, S.: *Experiencia de Usuario en Museos Virtuales* (2015)
8. Blackledge, J., Barrett, M.: Evaluation of a prototype desktop virtual reality model developed to enhance electrical safety and design in the built. *ISAST Trans. Comput. Intell. Sys.* **3**(3), 1–10 (2012)
9. George, D., Mallery, P.: *SPSS/PC+Step by Step: A Simple Guide and Reference*. Wadsworth Publishing Co., Belmont (2003)