Gamification techniques in tourism, application test, Casa Mosquera Museum

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ABSTRACT The use of Information and Communications Technologies in the tourism sector is a topic of a great ac-
tuality, because of its capability of adding interactive elements and promoting “new” environments. This paper presents
a pilot experience using a serious game developed for the Mosquera House Museum, during the Holy Week 2015. The
experience was pretty positive because of its capability to encourage learning and reception of information by museum
visitors. Both, tourists and museum staff mention that the application was a key to improve –by appending interaction
and dynamism– the experience, and they suggest similar developments for other places. The pilot also showed that both,
the Wi-Fi access throughout the museum, and the possibility to download the application from an on-line store (e.g., Play
Store, App Store), are required, in order to avoid the loss of potential users. This type of application can revolutionize
the tourism industry by introducing more scenarios, because these are so attractive for visitors. The modern world and
the current technological environment are ideal for the evolution of applications of gamification techniques, not only in
tourism, but in other aspects of everyday life.

KEYWORDS Gamification, serious game, museum, Android, tourism.

RESUMEN Las Tecnologías de la Información y las Comuni-
caciones cobran gran importancia en el sector turismo, primor-
dialmente por su capacidad para agregar interacción y promover
la formación de nuevos entornos. Este artículo presenta una expe-
riencia piloto del uso de un juego serio desarrollado para la Casa
Museo Mosquera, realizada durante la Semana Santa de 2015. La
experiencia fue positiva, pues es claro que motiva a los visitan-
tes a aprender y a recibir información. Los turistas y el personal
del museo indican que ella dinamizó y mejoró la experiencia y
recomiendan su uso en otros ámbitos. El piloto mostró además
la necesidad de contar con Wi-Fi y tener la aplicación disponible
en una tienda on-line para evitar la pérdida de usuarios potencia-
les. Este tipo de aplicaciones puede revolucionar la industria del
turismo en la medida en que se escala a más escenarios. El mundo
actual y su entorno tecnológico son ideales para la evolución de la
aplicación de técnicas de gamificación, no solo en el turismo, sino
en otros aspectos de la vida cotidiana.

PALABRAS CLAVE Gamificación; juego serio; museo; An-
droid; turismo.
I. Introduction

The concept of gamification can be summarized as applying the dynamics of games in different areas, boosting people’s motivation, concentration and effort in their activities (Groh, 2012). The renewal of touristic experiences through the application of these techniques is causing the tourism concept itself to evolve (Xu, Weber, & Buhalis, 2013; Weber, 2014) and this is becoming a whole new field of study that promotes technological development in this area (Bonilla, 2013). When gamification is applied in education, entertainment and other learning environments, the product is known as a ‘serious game’ (Giessen, 2015; Manero, Torrente, Serrano, & Fernández-Manjón, 2015), and this applies to this case study.

Visiting a new museum is a great example of how an activity related with learning and an interaction process can be enriched through gamification techniques (Aguirrezabal, Peral, Pérez, & Sillaurren, 2014; Kim, 2015); the development of this work finally demonstrates that a serious game has a positive impact for the museum visitors, making their journey a dynamic and interactive experience.

II. Motivation

At present, tourist sites are undergoing a transformation due to the adaptations that they require to new technologies, which offer new services and options for tourists and also generate new experiences for them (Stock et al., 2014; Tang & Qiu, 2015). The Mosquera House Museum belongs to the network of institutional museums of Cauca University through the Vice Presidency of Culture and Welfare; it is a historical museum, with a collection of set pieces that celebrate the life of General Tomas Cipriano de Mosquera, hero of the homeland and four times president of Colombia (Vásquez, 1991). Given the above, it raises the need for a serious game, developed for mobile platforms, to provide visiting tourists with a unique and renewed experience.

Mosquera House Museum is visited by students from schools in the city, enthusiastic local tourists knowledgeable about history, and tourists from other parts of the country and the world, as confirmed by statistics presented by Ramírez, Chantre, and Delgado (2014). Depending on the volume of tourists, locals and visitors, the Holy Week period is the time during which there is the largest number of visitors to the Mosquera House Museum as a potential very great in the promotion tourist, la renovación de
III. Metodología

A. Bibliográfica

Para establecer la pertinencia y novedad del enfoque que se aborda, se realizó una revisión sistemática bibliográfica. Se seleccionaron como fuentes principales para la búsqueda: ScienceDirect, IEEE Xplore, Springer y ACM Digital Library, por ser las fuentes más sintéticas del área de ingeniería e ingeniería aplicada relevante. Se seleccionó un conjunto de palabras clave para encontrar, por un lado, la tendencia de gamificación y la gamificación con teléfonos móviles, y por otro, la especificidad de gamificación en museos y con teléfonos móviles. Según sea disponible la búsqueda se refina a título, resumen y palabras claves para evitar resultados no relevantes. Los términos de búsqueda fueron: gamification, gamification smart-phones, gamification mobile phones, gamification museum, gamification museum smart-phones, gamification museum mobile phones. Con base en los términos y las fuentes seleccionadas se encontraron los resultados que muestra la Tabla 1.

Una vez analizados estos resultados, se encontró que del ámbito de trabajos realizados en gamificación, cerca de 25%, están relacionados con trabajos mediados por teléfonos móviles, especialmente smartphones; en lo que respecta al ámbito de gamificación y teléfonos móviles, sólo cerca de 5% de los resultados son de esta temática y, dentro de ésta, sólo la tercera parte corresponde a trabajos mediados con teléfonos móviles o smartphones. Sin embargo, dentro de los resultados relevantes para el ámbito de este proyecto se destacan las experiencias presentadas en el Museo de Arte de Barcelona (Melero, Hernández-Leo, & Manatunga, 2015), que introduce actividades para escolares y, en general, propuestas aplicadas de mobile learning (Ver: Su y Cheng, 2013; García-Cabot, de-Marcos, y García-López, 2015; Pace y Dipace, 2015; Ma, Oikonomou, y...

|Keyword / Palabra clave| ScienceDirect| IEEE Xplore| Springer| ACM| TOTAL|
|-----------------------|---------------|-------------|---------|-----|-------|
|Gamification| 58| 204| 762| 592| 1,616|
|Gamification smart-phones| 2| 4| 175| 87| 268|
|Gamification mobile phones| 0| 11| 219| 179| 409|
|Gamification museum| 1| 0| 47| 39| 87|
|Gamification museum smart-phones| 1| 0| 16| 8| 25|
|Gamification museum mobile phones| 0| 0| 21| 14| 35|
|Total| 62| 219| 1240| 919| 2,440|

Museum and to the museum network of Cauca University generally, with an average of about 1,500 visitors per day. This, together with the Unesco (2009) recognition of Holy Week in Popayan as intangible cultural heritage, makes this period the best possible scenario in which to test the application.

Gamification is a concept that is gradually being used in similar spaces. It has great potential in tourism promotion, the renewal and rediscovery of destinations, by adding new attractions (Xu et al., 2013; Minazzi, 2015). Similarly, serious games, by definition, are a description of these applications, due to their objective of the gamification of activities that are not properly the subject of a game, the more so when the object of study is a museum.

III. Methodology

A. Bibliography

To establish the relevance and novelty of the proposed approach, a systematic literature review was conducted. The following were selected as primary sources for the search: ScienceDirect, IEEE Xplore, Springer and ACM Digital Library, these being the most synthetic area of relevant sources on engineering and engineering applications. A set of keywords was defined in order to find, on the one hand, the trend of gamification and gamification with mobile phones, and secondly, the specific use of gamification in museums and mobile phones.

According to their availability, the search was refined by title, abstract and keywords to eliminate irrelevant results. The search terms were: gamification, gamification smart-phones, gamification mobile phones, gamification museum, gamification museum smart-phones and gamification museum mobile phone. Based on the terms and the selected sources, the results shown in Table 1 were found.

After analyzing these results, it was found on the work scope of the gamification, that about 25% are related to work through mobile phones, especially smartphones; with regard to the scope of gamification and mobile phones, only about 5% of the results are on this subject and only a third of these are done through mobile phones or smartphones. However, among the results relevant to the scope of this project, the highlights include the experiences offered at the Art Museum of Barcelona (Me-
After visiting the museum about five times, accompanied by different guides with extensive knowledge, it is noted and the importance of conducting tests and prepare a report where the experience is documented.

B. Development

Based on what was stated in the motivation section and after several visits to the Mosquera House Museum, a serious game that takes into account the possible limitations of the museum environment is planned. Given its market penetration, it is proposed to develop this on the Android platform, with a user-friendly interface that accounts for the type of museum tour suggests that the interaction and the mechanics of implementation should revolve around reading QR codes. The type of game that arises is a tracking clues game in which the accompanying guide is important, and during the journey will help solve each of the clues given in the game. The design criteria of the application are basically divided into two parts, experiment design and application design, which in turn is divided into technical design and graphic design. These criteria are listed below:

Experiment design

After visiting the museum about five times, accompanied by different guides with extensive knowledge, it is...
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Proposed to energize this experience, where taking heed of the words of the guide is the main objective around which to turn the attention of users. Thus, a game to discover items in each room by following clues deployed, implementing the concept of a ‘mission’, is conceived (Melero et al., 2015). This can generate more interest in what the guide says, because in his narrative there are also clues to help solve each given mission.

For this experiment six missions are devised (Table 2), one for each room, including an initial task to verify the correct functioning of the device. A diagram describing the gameplay (the main operation of the application) is given in Figure 1, which is based on the work of Su and Cheng (2013); Garcia-Cabot et al. (2015); Pace and Dipace (2015); and Ma et al. (2011).

The aim of the missions is to give the user clues by which to guess an item in each room of the House Museum; this check is performed by scanning the QR code of each one. In order to develop each mission, the user must solve the clues given, taking into account the information displayed in the application, as provided by the guide during the tour. In addition, the decision flow case study is raised, considering its limitations, scope and other characteristics (Figure 2).

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**Table 2. Missions CMMApp / Tabla 2. Misiones CMMApp**

| Mission / Orden | Title / Título | Place / Lugar | Description / Descripción |
|-----------------|---------------|--------------|---------------------------|
| 1               | Try your scanner / Prueba tu scanner | Museum admission / Ingreso al museo | Your sole purpose is to check the correct installation of the QR code reader. / Su único objetivo es comprobar la correcta instalación del lector de códigos QR. |
| 2               | Learn to play / Aprende a jugar | Hall 1 / Sala 1 | Answer QR codes are located very close together, and their aim is to familiarize the user with the game mechanics. This mission takes advantage of the small size of the room. / Los códigos QR respuesta están ubicados muy cerca uno del otro, tiene como objetivo que el usuario se familiarice con el mecanismo del juego. Ésta misión aprovecha el tamaño pequeño de la sala. |
| 3               | Heroes’ Legacy / Legado de los próceres | Hall 2 / Sala 2 | Living room two is slightly larger. In this the normal search game unfolds, as the first full mission. / La sala dos es una sala un poco más grande, en ella se despliega una búsqueda normal del juego, es la primera misión completa. |
| 4               | Religious legacy / Legado religioso | Hall 3 / Sala 3 | The hall displaying the religious side of the great General and his brother is here; it lends itself to a more extensive search and has a wider path between each code. / Se recorre la sala que exhibe el lado religioso del gran General y su hermano, se presta para hacer una búsqueda más extensa y tener un recorrido más amplio entre cada código. |
| 5               | Legacy and life of the General / Legado y vida del General | Hall 4 / Sala 4 | It includes very personal components, and given the importance of the pieces exhibited here, it is the central mission of the game. / Incluye componentes muy personales, dado la importancia de las piezas aquí exhibidas, es la misión central del juego. |
| 6               | Religious art / Arte religioso | Hall 5 / Sala 5 | The last mission corresponds to a tour of religious art; the clues are more obvious and help a relaxed end of the tour, ending with the survey. / Última misión, corresponde a un recorrido por el arte religioso; las pistas son más evidentes y ayudan a finalizar el recorrido con algo de distensión, para finalizar con la encuesta. |

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**Figure 1. Gameplay diagram / Figura 1. Diagrama de jugabilidad**

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El objetivo de las misiones es dar al usuario pistas mediante las cuales pueda adivinar una pieza dentro de cada sala de la Casa Museo; esta comprobación se realiza mediante el escaneo del código QR.
Application design
This design describes the characteristics that directly affect the implementation of the serious game, which are developed through our own methodology, adapted from the Scrum methodology, a well-established methodology for this type of technological development (Sisarica & Maiden, 2013; Landers et al., 2015; Pérez-Valle et al., 2014).

Technical design
The core of the technical component turns around interaction with the QR code reader. Thus, from the technical point of view, the compatibility of the application is developed with a reader. Based on this, two functions, the game (to solve the missions) and the reading of the codes for redirection to a page with more information about the selected item, are implemented.

To create the missions, taking into account the data obtained during visits to the Museum, with this and the tour, sequential missions to follow the route that takes place are designed. The third feature that arises is mapping, where the location of the various showrooms and the tour that takes place during the visit are shown. The implementation is done using native Android in the Android Studio development environment.

Graphic Design
User interfaces are designed taking into account código QR de cada una de ellas. Para desarrollar cada misión el usuario debe resolver las pistas dadas, teniendo en cuenta tanto la información desplegada en la aplicación, como la que ofrece el guía durante el recorrido. Además, se plantea el flujo de decisión del caso de estudio teniendo en cuenta sus limitantes, alcance y demás características (ver flujo en la Figura 2).

Diseno de la aplicación
En este diseño se describen las características que influyen directamente en la implementación del juego serio, las que se desarrollan mediante una metodología propia, adaptada de la metodología Scrum, una metodología muy afianzada para este tipo de desarrollos tecnológicos (Sisarica & Maiden, 2013; Landers et al., 2015; Pérez-Valle et al., 2014).

Diseno técnico
El núcleo central del componente técnico gira alrededor de la interactividad con el lector de códigos QR, de este modo, desde el punto de vista técnico, se desarrolla la compatibilidad de la aplicación con un lector; con base en ello se implementan dos funcionalidades, la de juego (desarrollar las misiones) y la de lectura de los códigos para la redirección a una página con más información acerca de la pieza seleccionada. Para la creación de las misiones se tiene en cuenta los datos obtenidos durante las visitas a la Casa Museo, con esto y con el recorrido se diseñan las misiones secuenciales que sigan la ruta que se realiza. La tercera funcionalidad que se plantea es la de mapa, donde se muestra la ubicación de las distintas salas de exposición y el recorrido que se realiza durante la visita. La implementación se realiza en Android nativo utilizando Android Studio, Entorno de Desarrollo.

Diseno gráfico
Las interfaces de usuario se diseñaron teniendo en cuenta la imagen institucional proyectada en la página web de la Casa
Museum, and the norms of usability for the presentation of information and disposition of the elements for the users, with base in the works of Herbert et al. (2014); Amriani et al. (2013); and de-Sousa-Borges et al. (2014). The design and generation of images and other elements necessary for the interfaces were performed using specialized editors. Some of the interfaces generated, based on usability considerations, are presented in Figures 3, 4 and 5.

In the graphic, the different labels were also developed with the QR codes that are deployed in the House Museum (Figures 6 and 7) and a poster that served as a motivator during the experience (Figure 10). Figures 8 and 9 show the deployment of QR tags on the facilities of the House Museum and the conditions in which the tags were found at the time of interaction with visitors to the museum; similarly, the poster shown in Figure 10 served to attract the attention of visitors and to explain how to start the experience of the visit. This graphic part is developed taking into account the environment of the House Museum, meaning that the elements are both striking and at the same time consistent with the sobriety of the place.

IV. Prueba piloto

Antes de realizar el despliegue y la prueba, se realizó un estudio previo mediante el cual se comprobó el correcto funcionamiento de todo lo desarrollado, por ejemplo, que los códigos QR para cada etiqueta fueran los indicados (Tabla 3). La ve-
IV. Pilot test

Before deployment and testing, a preliminary study was realized to ensure the correct operation of everything developed, for example, that the QR codes for each tag were appropriate (Table 3). Verification of this list was carried out in the company of the Director of the House Museum and a number of guides at different times. The events of this case study took place on 1–4 April; on the first day the pilot test was conducted, and the remaining time was dedicated to the central test, because this was when the museum was exhibiting the most interesting item in its collection: the heart of the hero Tomas Cipriano de Mosquera, which is on display only once a year, during Holy Week, given its aforementioned significance.

During this test the following limitations and weaknesses were detected:

- the compatibility of the application only with Android devices;

Table 3. Pilot test checklist

| Item                                                      | Check |
|-----------------------------------------------------------|-------|
| The QR codes are legible (different lighting conditions) | Ok    |
| The codes correspond to the figure                        | Ok    |
| The application works in the museum                       | Ok    |
| The information on each page corresponds to each figure   | Ok    |
| The motivational poster is visible to visitors            | Ok    |
| Verify connectivity inside the museum with different operators | Ok    |

Mission 1 works / Funciona misión 1 Ok
Mission 2 works / Funciona misión 2 Ok
Mission 3 works / Funciona misión 3 Ok
Mission 4 works / Funciona misión 4 Ok
Mission 5 works / Funciona misión 5 Ok
Mission 6 works / Funciona misión 6 Ok
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V. Findings and conclusions

During Holy Week 2015 the display of the CMMApp [Casa Museo Mosquera App] application was trialled in the Mosquera House Museum, considering the design, implementation and other specified considerations. In addition, for this deployment a small survey was conducted (Figure 11) in order to get direct feedback from users and also to test the data developed in a totally live environment.

The Mosquera House Museum received an average of 1,200 visitors per day, of which about 50% received information about the application. Not all the visitors could be taken into account because of the large volume attending.

Data Analysis

With the feedback received and the data obtained from different sources, such as the experimental observation and sources of the museum, we can discuss the successful testing and deployment of the application.

The server where the application was stored logged about 105 downloads of the application, of which 71% corresponded to successful installations.

Feedback was received from 41% of those who installed the application, demonstrating a willingness to participate in the whole experience. The difference between the number of people who tried the experience and the number receiving the initial information was caused by various factors, as expected from the limitations known at the time of deployment, as was corroborated during the test. Based on a permanent observation made by others, the number of people willing to try the full experience with the game was reduced as a result of factors such as the following:

- the lack of wi-fi in the House Museum, which necessitates that the user has a data plan;
- the limited availability of people’s time;
- the limited availability of space in devices; and
- the absence of the application in PlayStore.

Significantly, most of these limitations depend on the application environment of the test, in this case, the particular House Museum environment.
El servidor donde se almacenó la aplicación registro alrededor de 105 descargas de la aplicación, de las cuales el 71% correspondió a instalaciones exitosas.

Se recibió retroalimentación del 41% de quienes instalaron la aplicación, lo que demuestra una buena disposición para realizar la totalidad de la experiencia. La variación entre el número de personas que realizó la experiencia, comparado con quienes recibieron la información inicial, fue causada por diferentes factores, tal como se esperaba, a partir de las limitantes conocidas al momento del despliegue, las misma que se corroboraron durante la prueba. Con base en una observación permanente realizada por terceros, la población dispuesta a realizar la experiencia completa con el juego fue disminuyendo por efecto de factores tales como:

- visitantes que solo querían tomar fotografías (un estimado del 10% de los visitantes);
- visitantes que querían hacer una visita rápida sin guía (5% estimado);
- visitantes que no tenían un smartphone en el momento (20% estimado);
- visitantes que tenían un smartphone, pero con un sistema operativo diferente de Android (25% aproximadamente);
- visitantes con un smartphone Android, sin plan de datos (50% aproximadamente); y
- visitantes con smartphone con sistema operativo Android, pero sin espacio en el dispositivo (25%).

De la realimentación recibida, se tiene que la aplicación aun con los limitantes nombrados, tuvo un gran nivel de aceptación, un gran grupo de personas expresó, no solo en la encuesta, sino también de manera oral, la necesidad de tener la aplicación en una tienda de aplicaciones y de avanzar en su compatibilidad con otros sistemas operativos móviles (especialmente iOS). Otra observación predominante fue la de tener más aplicaciones de este tipo en otros museos y sitios históricos de la ciudad.

A partir de los datos mencionados, se puede afirmar que al usar la aplicación se logra introducir una gran mejora e innovación a la experiencia de la visita a la Casa Museo, dado que la mayoría de usuarios consideró que la aplicación no solo le agrega dinámica, sino también de manera oral, la necesidad de tener la aplicación en una tienda de aplicaciones y de avanzar en su compatibilidad con otros sistemas operativos móviles (especialmente iOS). Otra observación predominante fue la de tener más aplicaciones de este tipo en otros museos y sitios históricos de la ciudad.

A futuro, se puede: implementar un mayor número de misiones, con diferentes niveles de dificultad y con logros que permitan premiar al usuario a alcanzar diferentes tipos de medallas dentro del juego; añadir compatibilidad con redes sociales, como Facebook, para permitir la creación de perfiles y facilitar que el usuario pueda compartir los logros obtenidos; y ofrecer soporte para otros idiomas, dada la diversidad del origen de los visitantes extranjeros.

Los datos obtenidos permiten ver la influencia positiva que tiene la gamificación aplicada en el turismo. El interés mostrado, incluso por las personas que por alguna razón no pudieron realizar la experiencia completa, refleja que la experiencia se renueva no solo desde el punto de vista educativo, sino que también llama mucho la atención de su desarrollo en un espacio en el que no se espera poder jugar.
A manera de conclusiones se resaltan las siguientes:

• Este tipo de aplicaciones fomenta el aprendizaje y la recepción de la información por parte de los visitantes al museo.
• Los turistas recomiendan realizar este tipo de aplicaciones, tanto para otros museos, como para otros lugares históricos de la ciudad.
• Las limitantes disminuyen la cantidad de personas que interactúan con la aplicación, no tener Wi-Fi en las instalaciones de la Casa Museo, no permitió que más usuarios interesados utilizaran la aplicación y leeran las etiquetas QR.
• Es recomendable tener la aplicación en una tienda de aplicaciones para facilitar su instalación. La aplicación tuvo gran acogida entre el personal del museo y los visitantes, dinamizó la visita y la mejoró, convirtiéndola en una experiencia interactiva.
• Este tipo de aplicaciones pueden revolucionar la industria del turismo en la medida en que se escalen a más escenarios, porque además son muy llamativas para los visitantes.
• El mundo actual y su entorno tecnológico son un entorno ideal para la evolución de la aplicación de técnicas de gamificación, tanto en el turismo, como en otros aspectos de la vida cotidiana.
• Los juegos son una experiencia tecnológica llamativa para todos los públicos y motivan a los visitantes a recomendar los sitios que visitan, gracias a las buenas experiencias que representan los entornos renovados con este tipo de aplicaciones tecnológicas.

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at the House Museum, which prevents more interested users utilizing the application and reading the QR tags.
• It is advisable to make the application available in an app store for easy installation. The application was well received among museum staff and visitors, and energized and improved the tour, making it an interactive experience.
• Such applications could revolutionize the tourism industry to the extent that it expands to more scenarios, because they are very appealing to visitors.
• The current world and its technology are an ideal environment for the evolution of the application of gamification techniques, both in tourism and in other aspects of daily life.
• Games are a striking technological experience for all ages and encourage visitors to recommend the places they visit, thanks to their good experiences with renewed environments when using this type of technological application.

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