Immersive UX: A UX Evaluation Framework for Digital Immersive Experiences in the Context of Entertainment

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Abstract: Digital Immersive Entertainment attracts thousands of people worldwide and can awaken new feelings and sensations in those who experience it. However, there is no standardized way of evaluating User eXperience (UX) and which UX measures should be considered in this context to determine whether the immersive experience was enjoyable and engaging for the audience. After considering how to evaluate the user experience in the context of immersive entertainment, we developed the Immersive UX, a UX evaluation framework considering important UX measures related to the evaluation of the immersive experience. In this sense, we based our framework on evaluating the following UX measures: flow, presence, and engagement. We carried out a study to investigate our framework's feasibility by using it in a UX evaluation. This study examines how users felt when participating in a simulated cinema experience where they interacted with other people using different systems to support the immersive experience. We observed that our framework was able to capture what users feel when going through a systems-driven experience to support immersion. We were able to investigate users' expectations and satisfaction, which allowed us to analyze whether the user's immersive experience guided by digital systems was positive or not.

1 INTRODUCTION

User eXperience (UX) has attracted interest in recent years (Pettersson et al., 2018). This interest may be related to the fact that usability limitations have become more visible as interest and investigations regarding UX have become more evident (Law et al., 2009). According to Russo et al. (2015), in the past, the systems were intended to provide useful and usable functionality, and today, they try to involve users in positive and engaging experiences. In this sense, UX evaluation has become an important activity to assess the quality of the products, aiming to identify improvement opportunities and meet consumers' expectations (Nakamura. et al., 2020). This change in focus has caused a growth in studies involving the UX evaluation (Müller et al., 2016).

The change in the systems' goals has also caused changes in the paradigms of interaction, allowing the emergence of applications focused on immersive entertainment (Marques et al., 2020; Lee et al., 2020). This type of entertainment can be made possible by immersive technologies or interactive applications, which reduce the boundaries between the physical, virtual, and simulated worlds, which allow users to experience a sense of immersion (Suh and Prophet, 2018).

However, the emergence of interactive applications has brought new challenges. For example, the understanding of how interactions with this kind of applications occur in practice is still limited (Halskov et al., 2014). Marques et al. (2020) argue that it is necessary to investigate how to evaluate the quality of the interaction provided by this type of applications.

In order to investigate how to evaluate the UX of digital immersive entertainment, we conducted an empirical study where users were immersed in an experience that simulated a cinema. To assess each user's experience, we developed a method based on the Expectation-Confirmation Theory (ECT) (Oliver,

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1980). Following the ECT model, we developed observation metrics based on Flow, Presence, and Engagement, which are important UX attributes and are described in the next section.

Furthermore, we developed two questionnaires, one for expectation and the other for satisfaction. Our results showed that the observation metrics allowed us to collect valuable data about the users' digital immersion experience. Through the questionnaires, we were able to understand the reasons that explain the users' behavior observed during the empirical study. In this sense, our framework can be considered an approach to evaluate UX in an innovative context, as in immersive experiences guided by digital systems.

2 BACKGROUND

UX includes various elements of what a user experiences before, during, and after interacting with a product (Oyedele et al., 2018). Moreover, UX is associated with a broad range of fuzzy and dynamic concepts (Law et al., 2009). In this sense, there are several and different definitions of UX in the literature. However, many researchers agree with the ISO 9241-210 definition: "The user's perception and responses resulting from the use of a system or a service."

According to Tcha-Tokey et al. (2016), there are differents UX measures to evaluate immersive experiences. In this paper, we focus on the flow, presence, and engagement as UX measures since these measures are related to the digital immersive experience context (Suh and Prophet, 2018; Tcha-Tokey et al., 2016).

Csikszentmihalyi (1991) introduced the concept of flow and defined it as "the holistic sensation that people feel when they act with total involvement. During the state of flow, people are immersed in an activity, fully control their actions, center their focus of awareness, as well as lose their self-consciousness and the sense of time passing (Huang et al., 2011).

Presence is defined as "the user's sense of being there" (Tcha-Tokey et al., 2016), and its concept can be grouped into two categories: physical presence and social presence (Pallot et al., 2013). In this study, due to our research context, we adopted the concept of social presence as our concept of presence. The social presence theory is related to the users' feeling of having another person involved in the same interaction (Pallot et al., 2013).

Engagement is "the state of consciousness where a user is completely immersed in and involved in the activity at hand" (Ren, 2016). Engagement is necessary to maintain the meaningfulness and efficiency of the interaction occurring between computers and users (Goethe et al., 2019). According to Shin (2019), the three main measures widely used to describe engaging experiences are immersion, flow, and presence. In this sense, the Shin's definition of immersion is strictly related to the definition presented at the beginning of the paragraph (Ren, 2016). Based on the results of these researches, here, we see engagement as a result of the level of those three measures.

2.1 The ECT Model

Expectation-Confirmation Theory (ECT) was initially proposed by Oliver (1980), originally in Marketing field (Chou et al., 2012). However, the ECT model has also been used in the context of Information Systems (IS), to examine cognitive beliefs and the effects that influence the intention to continue using (continuance) IS (Bhattacherjee, 2001). ECT has five constructs: expectation, performance, confirmation, satisfaction, and repurchase intention (Oliver, 1980).

Since we are interested in evaluating immersive experiences through digital systems, we based our framework on the ECT Model. We adapted the ECT Model to fit in our context. Whereas confirmation and repurchase intention are not objects of assessment in the context of digital experience, we used only three constructs of the ECT Model: (i) expectation, which refers to the condition of those who expect an event, in our case what the person expects from the immersive experience; (ii) performance, which refers to a person's perceptions about the real performance of an event, that is, what is provided by the product or service; (iii) satisfaction, which is the measure of the pleasure obtained after using a product. Here, satisfaction is related to the moment after the immersive experience and is strongly linked to the person's expectations before the experience.

2.2 Related Work

Due to the recent technological advancements, immersive experiences are most related to the experiences provided by immersive technologies such as Virtual Reality (VR) technology (Suh and Prophet, 2018). However, immersive experiences do not refer only to experiences intermediated by VR technologies.

For instance, (Häkkilä et al., 2014) explored how to enable interaction with content in the context of 3D cinema by employing a mobile phone. They were particularly interested in the UX of the interactive 3D cinema concept and how different elements and interaction techniques are perceived. The viewers used

their devices to retrieve information about the artist.

The results showed, among other aspects, that the interactive content must not only be linked to the real content of the video, but also integrated into contexts in which it does not cause conflict with the immersive experience with the movie. In this paper, we propose a similar cinema immersive experience. However, our goal is to investigate how to evaluate the overall UX in the context of immersive entertainment.

This way, we proposed a framework called Immersive UX and carried out a study to verify its feasibility. We present the framework in the next section.

3 IMMERSIVE UX FRAMEWORK

To understand the user's behavior in relation to the immersive experiences, we aimed to investigate the main stages of the experience. In this sense, the ECT Model helped in the construction of our framework. We have established three steps based on three constructs of the ECT model (see section 2.1). The first stage we call expectation. The second stage refers to when the user is experiencing immersion, called performance. The third stage is the assessment of user satisfaction with the proposed experience.

To obtain data for each stage of the framework, we have developed different ways of collecting user data. For the expectation and satisfaction stages, we developed two different questionnaires. In the performance stage, considering that users cannot be interrupted because they are immersed in the experience, data is collected through observation. In the satisfaction stage, we collect data related to the three UX measures (flow, presence, and engagement) used to evaluate the immersive digital experience (see Section 2).

We made a Technical Report (TR) (Alves. et al., 2021) to complement this paper since we have page limitations. The TR contains both the questionnaires of expectation and satisfaction. Besides the questionnaires, the raw data of the study are available in the TR (Alves. et al., 2021).

In the expectation stage, we developed a questionnaire with eight questions (Alves. et al., 2021). This stage aims to capture the user profile and their affinity with the digital systems necessary to perform the immersive experience that is being proposed. The first seven questions are closed, with predefined answer options. However, in question 8, we use an open question so that the participant would provide their expectations.

During the observation stage, we highly recommend using the observation technique that best suits the evaluation context. The most important aspect of this stage is to observe the users' attitudes and interactions that can help understand the UX measures evaluated to determine if the immersive digital experience was pleasant. For example, conversations between users can indicate the presence, just as concentration moments can indicate a reasonable flow rate.

Finally, in the satisfaction stage, we have the main questionnaire aiming at assessing the indicators of the users' experience. The questionnaire comprises 13 questions (Alves. et al., 2021). The first 12 questions are closed and we designed them to extract information about each UX measure. Each question has a score, shown in greater detail in subsection 3.1. The question 13 is open, so that the participant may leave a compliment, critic or suggestion related to the immersive experience.

3.1 Scoring

The satisfaction questionnaire (Alves. et al., 2021) is composed of four questions for each UX measurement used for the evaluation (flow, presence and engagement). The questions have different answer options. Each option has a related score ranging from 0 to 4 points. Table 1 shows the values for each response. According to Table 1, the score of the UX measurements were constructed as follows:

(i) the alternatives selected by the participants are added together with the result and assigned to the measurement of UX that the questionnaire's question represents.

(ii) each UX measurement may reach a maximum score of 16 points. This amount of points is obtained when one takes the highest score (i.e., 4) and multiplies by the amount of questions that represent a measurement of UX (which is also equal to 4).

(iii) the maximum score that a questionnaire can achieve by being completely answered is equal to 48 points. This total is the result of the 3 measurements of UX multiplied by the maximum 16 points of each measurement.

(iv) the number of participants is defined by a variable N. If all participants marked the maximum values, in all alternatives, the value that a session would reach can be obtained by multiplying the value of N by the maximum possible score, i.e., 48.

$$N * 48 \tag{1}$$

(v) the maximum score that a measure (PM) can receive is the multiplication of the number of participants (N) by the maximum 16 points of each measurement of UX, therefore:

$$PM = N * 16 \tag{2}$$

For visualization of these data, we use radar graphs to represent the UX measurements, and their respective values thus forming a triangle. To analyze this graph, we interpret it as follows. The outermost point of the triangle represents the maximum score that a measure can obtain. In contrast, the satisfaction questionnaire's participants' points are the most innermost in the triangle.

The closer to the outer triangle indicates the participants felt more immersed in the experience. An example of the radar graphs can be found in the Figure 1.

Table 1: Scoring table.

Ux Measure	Q1	Q2	Q3	Q4
Flow	a - 4 b - 3 c - 2 d - 1 e - 0	a - 4 b - 3 c - 2 d - 1 e - 0	a - 4 b - 3 c - 2 d - 1 e - 0	 a - 4 b - 2 c - 0
Presence	a - 4 b - 3 c - 2 d - 1 e - 0	 a - 4 b - 2 c - 0	a - 4 b - 3 c - 2 d - 1 e - 0	a - 4 b - 3 c - 2 d - 1 e - 0
Engagement	a - 4 c - 0	a - 4 b - 3 c - 2 d - 1 e - 0	a - 4 b - 3 c - 2 d - 1 e - 0	a - 4 b - 3 c - 2 d - 1 e - 0

4 EMPIRICAL STUDY

Due to the context of the pandemic arising from COVID-19, we planned an immersive experience following the rules of protection and prevention, adopted to respect the social distancing. For this, we performed a home cinema, which emulated a movie session. To do so, the participants met in a video call and watched a series of terror short films "together", thus simulating a movie session in which the participants could talk freely during the session.

We conducted the study with a total of 30 participants, 19 men and 11 women. The participants were aged between 19 and 28 years (average age of 22.1), which shows that a young audience was reached. There were 6 short sessions with 5 participants in each session. Each session followed the three stages of the immersive UX framework that we detailed in the next subsections.

4.1 Expectation Stage

For the first stage of the empirical study, we sent the expectation questionnaire to the users who had agreed to participate in the empirical study. It contains a brief explanation of the study, the instructions for the session's day, and the questions to analyze the user's expectations.

When the participants receive the expectation questionnaire, they become aware of the study and signs the consent form (CF). They also select the day of the session he/she wishes to attend, and fills out the expectation questionnaire with his/her answers.

4.2 Performance Stage

In this stage, the evaluator's team observed the participants when experiencing the immersive digital experience. We presented the short films via a website called MyCircle[1], where it is possible to create a room and show the same video simultaneously for all the participants.

The sessions had an average duration of 16 minutes each and, once it had begun, the evaluators could not interact with the participants while they simultaneously watched the session online. We designed the experience so that the participants felt being in a real cinema session, that is, that they felt the presence of friends, even if each participant was in their home.

To allow observation of participants during the empirical study, we use the Google meet[2]. The Google meet tool allowed the use of microphone and camera, enabling the use of a fly on the wall style observation technique (Hanington and Martin, 2012). The fly on the wall technique permits gathering information by observing and listening discreetly to users, without their direct participation, or causing interference in the observed behaviors (Hanington and Martin, 2012). Thus, the technique allowed us to analyse the behavior of participants in each UX measure analysed (flow, presence and engagement).

On the day of the session, the participants received a link to a room on Google Meet, where all participants in that session would be present online. The webcam, as well as the user's microphone was used to visualize the reactions and behaviors following the fly on the wall technique. During the observation, the data were recorded for further analysis. Participants could talk freely during the session.

[1] www.mycircle.tv
[2] https://meet.google.com/

4.3 Satisfaction Stage

After the performance stage, where the empirical study is carried out, and the proposed immersive digital experience is completed, participants receive a questionnaire to assess their satisfaction with the experience. As we stated previously, in this stage, we collect the main data to evaluate the UX. All the data gathering in this stage are analyzed and displayed using radar graphs.

We conducted a pilot study to check the framework's suitability and some points for improvement before using it in the empirical study. After making some adjustments to the questionnaires, we performed the empirical study, and we present the results in the next section.

5 RESULTS

In this section, we present the results obtained in the study we carried out to evaluate the feasibility of our framework. First, we present the results of the expectation stage to characterize the participants. Then, we present the performance and satisfaction results together, as they are complementary and better understood if analyzed together.

According to item (v) of Section 3.1, we have value N as being equal to five participants per session. Thus, the maximum score that a measure could obtained in the session is 80. Therefore, all radar graphs presented in subsection 5.2 will have 80 points as the default value in the blue triangle (representing the maximum score) in each UX measurement.

5.1 Results from Expectation Questionnaire

The first question (Alves. et al., 2021) was asked to identify whether the participant considers himself a sociable person. We provide an example of sociable, which consisted of a person who gets along well with others, is friendly, and participates in the social environment in which he/she is inserted. We used this data to discuss whether the result would imply in the steps following the expectation. The result was that 86.7% of the participants considered themselves sociable, i.e., they can quickly adapt to the environment and are friendly to other participants. In contrast, 13.3% of the remaining participants did not consider themselves sociable.

Following, of the total participants, 56.7% agreed that participating in group activities without their friends interferes to a reasonable extent with their experience. A total of 23.3% pointed out it would not interfere, and 20% agreed it would definitely interfere. With this result, we expected that perhaps there would be a certain degree of inconsistency coming from most of the participants during the session as their social circle of friends would not always accompany them.

A large part pointed out they like watching movies, with the difference that 53.3% watch movies frequently and 43.3% do not usually watch movies frequently. A small proportion of 3.4% reported that they do not like to watch movies but may watch them depending on the occasion. Complementing this question, for which the participants could mark both options, 56,7% answered that they like to watch movies at home and 56,7% answered that they like to watch in the cinema, and we observed a balanced preference among the options.

All participants had the habit of using video-call applications. Even so, there is a difference that 73.3% usually use these tools in their daily life in general, while 26.7% use only them for work and/or study.

In regards to the context of the experience, we obtained the following results: only 13.3% of the participants have the habit of watching films "together" while at the same time separately, and 46.7% had already had this experience, but do not do it frequently. Besides, 40% had never participated in anything similar.

We also analyzed how the participants considered their degree of concentration to determine whether the experience sufficiently kept their attention. The results showed 60% maintained concentration depending on what was going on at that moment and 23.3% reported that they are attentive regardless of the situation. On the other hand, 16.7% do not consider attentive.

Finally, the data in the last question were collected so that it was possible to compare the first impressions of the study subjects with what the experience would provide. Since this question was open, we used the method of Underlying Discourse Unveiling Method (UDUM) (Nicolaci-da Costa, 2007) to categorize the comments made by the participants. The comments were analyzed after completing all sessions, and the satisfaction results sought to understand whether the public's expectations had been met. Thus the comments were divided into three groups.

The first group is called "High Expectations", and users provided answers in addition to what the experience might involve, such as the use of advanced sound equipment. In this category, only five responses were obtained, being the minority of the results.

The second group is called "Null Expectations", in which are listed responses such as the one that a participant proffered by stating *"I have no expectations"*. In this case, the answer ended up not being considered when analyzing the fulfillment of public expectations after the experience. In this group, we obtained a total of 9 responses.

The third group is called "Realistic Expectations", in which the participants' expectations match what the experience was able to provide. For example, a response that says *"I think I'm going to watch a video "together" with other people, I hope it's going to be a cool one"*. In this group, we obtained 16 comments, which were the majority of the answers.

5.2 Performance and Satisfaction Results

The radar graphs analysis is as follows: the maximum score of each UX measurement is represented by the outermost triangle in blue. The participants' answers in the satisfaction questionnaire are represented by the innermost orange triangle, with the values representing the flow, presence, and engagement of a session. The closer this orange triangle is to the blue triangle, the more the experience was perceived as engaging and immersive.

5.2.1 Session 1

In the performance stage of session 1, the participants had a high degree of interaction, and there was constant conversation. Furthermore, there were some problems, such as loud noises of a participant's audio. However, it did not hinder the experience.

Despite the problem described above, satisfaction reflected what was observed during the performance phase. As can be seen in Figure 1, the flow reached 57 points in this session, showing that the audio noise hindered the participants' concentration. However, the presence reached 69 points, showing that the participants noticed the conversation during the session. Finally, the biggest result was engagement, with 70 points. As engagement resulted from flow and presence, we noticed that the conversations were a positive aspect for the participants and made them feel more engaged in the experience.

5.3 Others Sessions

Due to the limitations of pages allowed for paper submission, the results of the other short film sessions can be found in the Technical Report (TR) (Alves. et al., 2021) where they are more detailed. We recommend following the reading of the paper with the TR (Alves. et al., 2021). In the next section, we will discuss data from all study sessions.

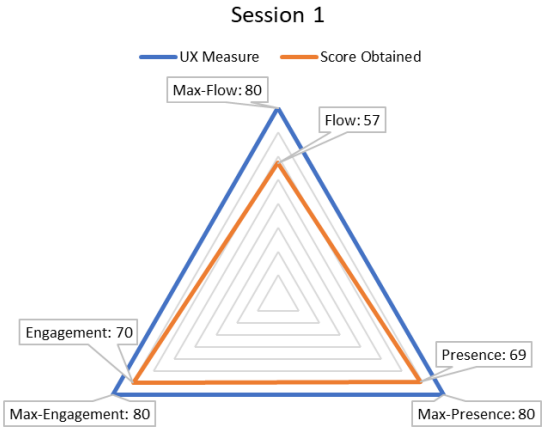

Figure 1: Session 1 values for the measurements of UX.

6 DISCUSSION

Overall, the results showed that the Framework developed to evaluate the UX of immersive digital experiences allowed understanding the participants' experience. Considering the results we collected, the participants' behavior during the sessions (performance stage) was reflected in the satisfaction questionnaire's data (satisfaction stage). We highlight that we presented the same short film in all sessions.

To demonstrate this result, we highlight the data obtained from some sessions, such as Sessions 1 and 3 (this data can be found in the technical report (Alves. et al., 2021)). In these sessions, it is possible to observe that the presence was greater than the flow (see the figures 1 and 3 (Alves. et al., 2021)). The result indicates that the participants' constant interaction through conversations was confirmed by the answers provided in the satisfaction questionnaire applied after the experience. It is noteworthy that these sessions' participants were not part of the same social circle, i.e., they did not know each other previously.

Considering that the presence consists of the socialization between the participants, which in the experience reported here was reflected in the conversations between them, this may explain the fact that the result for flow was lower. Considering that the flow refers to the mental state in which the person is fully immersed in what he/she is doing, it was expected that the flow would be lower when the presence was higher.

This happens because, by interacting through the conversations, the participants switch their focus from

watching the film to devoting more attention to the other participants' conversations. In this case, this relationship between the measurements is not harmful. The experience context should define what is most important, a greater presence, or a greater flow. The participants' interaction is positive in the experience reported here, so this result can be considered favorable for the immersive cinema experience.

In Sessions 1 and 3 (Alves. et al., 2021), conversations increased the perception of presence (presence indicator) and decreased immersive cinema experience flow. However, during Session 5, we observed that the participants divided their attention between the conversations and focused on the films more harmoniously. We noticed that it was reflected in the satisfaction results after the experience (as shown in Figure 5 (Alves. et al., 2021)), where UX measurements are closer to each other.

As in Session 5 (Alves. et al., 2021), the participants' attention did not stray so much from the focus on the films, as happened in Sessions 1 and 3, and the flow was not greatly affected. However, it is still below the score for presence for the same reason as in Sessions 1 and 3, as previously mentioned. This relationship remains positive because it is considered that the interaction between the participants is something favorable for the experience, and the results of Session 5 show that the participants were immersed in the experience desirably because of the balance achieved.

However, in Session 6, the results of the UX measurements were the lowest among all sessions, as shown in Figure 6 (Alves. et al., 2021). As mentioned in the results, there was difficulty identifying whether some participants' reaction was caused by concentration or tedium since the participants did not interact as much as participants in other sessions during the performance. However, the final results showed two participants' dissatisfaction, causing a low UX score in the final result. These participants' discontent was not evident during the performance stage since Participant 1 interacted throughout the session, and Participant 2 seemed to be concentrating on the films. In this sense, the satisfaction questionnaire captured aspects that were not captured during the observation. This result is important to show that the satisfaction questionnaire allows a better understanding of the experience.

During the Session 6 (Alves. et al., 2021) results description, we pointed out the film's lack of sound to a participant as a problem. This fact occurred with Participant 1 and can be a justification for his dissatisfaction with the experience. Concerning Participant 2, it was not possible to identify through observation what may have caused his/her dissatisfaction.

Based on the results and the discussions presented in this paper, we have indications that the framework can be used to evaluate flow, presence, and engagement, important UX measures for the context of immersive digital experiences. However, even with the evaluator's observation during the performance, the evaluation is not always effective in identifying possible reasons for the results obtained in the satisfaction, as shown during the discussion regarding Session 6. This result may be an indication that the satisfaction questionnaire can be more assertive. However, the Immrsive UX Faamework shows itself as an alternative to evaluate immersive digital experiences.

7 CONCLUSION AND FUTURE WORK

In this paper, we described how the measures of flow, presence, and engagement can be evaluated in contexts of immersive digital experiences. To do so, we proposed a UX evaluation framework, called Immersive UX. As a result, we concluded that for an immersive experience simulating a home cinema, where people were physically separated (at home) but virtually together (online), the framework could capture these people's perceptions and show the degree of flow, presence, and engagement experienced by them.

Due to the pandemic context, we plan an experience for people to feel less distant from others in the pandemic, creating a digital immersive experience that reduces social distance, respecting physical distance. Our results showed that this immersive experience was positive. Therefore, it is necessary to carry out more studies to investigate how the framework behaves in other immersive entertainment contexts, such as in crowds and face-to-face groups.

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