

LEARNING AND EMOTIONAL-AFFECTIVE MUSEUM EXPERIENCE VIA TEXTUAL SENTIMENT ANALYSIS

APPRENDIMENTO ED ESPERIENZA MUSEALE EMOTIVO-AFFETTIVA ATTRAVERSO L'ANALISI DEL SENTIMENTO TESTUALE



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ABSTRACT

In this paper we propose a model to enhance emotional learning in museums by detecting visitor emotions through Google Forms surveys on virtual exhibits. We utilize sentiment analysis and physiological measures to understand emotional states, aiming to improve classification accuracy through multimodal analysis. Additionally, text analysis aids sentiment assessment, emphasizing the crucial role of feedback in visitor engagement.

In questo articolo proponiamo un modello per migliorare l'apprendimento emotivo nei musei rilevando le emozioni dei visitatori attraverso sondaggi di Google Forms su mostre virtuali. Utilizziamo l'analisi del sentiment e misure fisiologiche per comprendere gli stati emotivi, con l'obiettivo di migliorare l'accuratezza della classificazione attraverso l'analisi multimodale. Inoltre, l'analisi del testo aiuta la valutazione del sentiment, sottolineando il ruolo cruciale del feedback nel coinvolgimento dei visitatori.

KEYWORDS

Emotional Learning, Museum Experience, Textual Sentiment Analysis, Visitor Engagement, Virtual Exhibit.

Apprendimento emotivo, esperienza museale, analisi del sentimento testuale, coinvolgimento dei visitatori, mostra virtuale.

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Introduction

Recent years have witnessed a growing interest in understanding the impact of museum experiences on visitors' cognitive and affective processes. Within the scope of museum studies, there is a prevalence of studies focusing on how visitors learn in museum settings, such as studies of the influences of visitor behavior and preferences on learning; comparing learning by school groups and general visitors, or examining how exhibit characteristics and museum programs influence learning. By sharing this interest, our research is devoted to study the museum field on a particular aspect of visitor learning—learning about art—at a particular type of art museum—an art museum with a highly regarded collection of traditional European painting and sculpture i.e. Louvre Museum. This provides the specific context for our research. The difference with earlier studies on learning is that we aim to contribute to understand the learning in Art museums by investigating the relationship between cognitive and affective processes. This is in response to a widespread recognition that learning in art museums is not exclusively a cognitive, knowledge-based activity, but it involves the activity to appreciate works of art, and to like, and to feel comfortable with Art. This is true of museum visitors with a variety of levels of expertise in Art. Learning to be comfortable with Art, and to find personal meaning in Art is highly associated with affective processes and is likely to be of particular importance to visitors learning what an important art collection has to offer them. Affective learning involves outcomes such as developing beliefs, and feelings about a stimulus object, and it may occur with little conscious awareness. We propose that affective learning processes provide a foundation for continued interest in Art, and deeper cognitive learning about Art. This occurs for art enthusiasts and novices alike. For instance, someone who comes to believe that art is an important means of expressing human thought and emotion is likely to look for art works that illustrate this idea and is likely to engage in deep thought and learning to confirm this belief.

The objectives of this work can be defined by two important museum-derived methods. These methods are for enhancing visitors' personal experiences and for improving general museum processes. The first method is to improve the visitors' experiences by understanding their cognitive and emotional reactions to specific exhibits and to use this understanding to develop methods of enhancing exhibit interpretation through social media collaborative platform, using Google Forms to presents surveys and questionnaires to learners. The second method is the development of affective and cognitive evaluation tools for use within museum communities that can provide feedback about the scholarly and pedagogical impact

of museum resources, in which the tools will be used to improve resource quality (Mansoury et al, 2020), (Damschroder et al, 2022). This research will address both of these methods. The results of this research will have an immediate impact in the form of improved exhibit resources and have potentially long-reaching impacts for museum communities in general.

1. Museum in the modern information space: potential of social networks

The pandemic compelled museums to explore alternative ways to engage with visitors, leading to a predominant shift towards digital formats (Giannini et al, 2022). An intriguing finding from research conducted by ICOM was the significant increase in digital activities. Prior to the pandemic, digital technologies were scarcely utilized in museums, and digital art was virtually nonexistent (ICOM, 2020), (ICOM, 2021). However, the crisis prompted museums to reconsider their strategies, analyze demand dynamics, and innovate virtual solutions to replace physical interaction. Consequently, virtual tours, online collections, exhibitions, learning programs, and the active use of social media, podcasts, and even video games emerged as alternative avenues for cultural exploration. While digital alternatives cannot fully replace traditional museum visits, they offer new and supplementary opportunities for relevant institutions (UNESCO, 2021). For instance, at the onset of the pandemic's first wave, China's National Cultural Heritage Administration urged museums to showcase their collections online to boost public morale (British Council, 2020). Despite museums offering online catalogs before the pandemic, displaying digital content online has been associated with legal uncertainties due to copyright variations (World Intellectual Property Organization, 2019).

Additionally, access to necessary equipment for content digitization posed a challenge, leading many museums worldwide to partner with Google Arts & Culture for high-quality internet content (Quinones Vila, 2020). Though online collections primarily attract students, scholars, and researchers seeking specific information, they lack the social interaction facilitated by traditional museums (Grant, 2020). The COVID-19 crisis accelerated the adoption of digital tools and virtual reality technologies among museums that had to close during lockdowns (Dawson, 2020). According to ICOM, at least 17 % of museums globally activated their digital presence during the pandemic, with the integration of social networks, live event streaming, and online educational programs pushing this figure to nearly 50 % (ICOM, 2020). Institutions with pre-existing comprehensive digital strategies transitioned more smoothly than those without, raising questions about the maturity and sustainability of these methods (American Alliance of Museums,

2021). Major museums worldwide, such as the Metropolitan Museum in New York and the National Museum of Modern and Contemporary Art in Seoul, had already initiated digital projects pre-pandemic, including virtual tours (UNESCO, 2021). The pandemic spurred these initiatives' expansion, broadening their reach (Coates, 2021) The pandemic's positive aspect on museums was the opportunity for audience expansion through new digital approaches (Coates, 2021).

For instance, the National Museum of Singapore curated a virtual exhibition that offered a compelling sense of presence. This exhibition featured three-dimensional interactive animated displays showcasing historical illustrations, supplemented by an augmented reality (AR) program accessible for download onto visitors' electronic devices (National Museum of Singapore, 2022). Similarly, the Louvre Museum in Paris introduced the "Mona Lisa: Beyond the Glass" program, a virtual reality (VR) experience accessible both onsite and online. This innovative program integrates interactive graphical elements, immersive sounds, and dynamic moving images to delve into the painting's significance and contextual relevance (Coates, 2021). Research in the United Kingdom and the United States confirmed a diversified visitor base resulting from the transition to digital formats (Samaroudi et al, 2020) This shift prompted a reevaluation of museum activities in the digital space and their purpose in the virtual world. Digital technologies are increasingly pivotal for museums, not only as dissemination tools for information and entertainment but also for ensuring their viability (Noehrer et al, 2021). Access to museum collections digitally stimulates the creation of public goods, enhances access to research and educational resources, and contributes to people's well-being (Agostino et al, 2020). However, challenges persist, particularly for users with low computer literacy. The long-term structural impact of the pandemic on the museum sector necessitates addressing these challenges while leveraging digital tools to meet evolving needs (Newman et al, 2020).

Museums must adapt to a new approach, focusing on both physical and digital spaces to enhance accessibility, inclusivity, and financial sustainability (Art Fund, 2021). The digital transition has prompted museums to reassess their social roles and explore innovative ways of attracting new audiences (Raimo et al, 2021). Overall, digital activities have strengthened relationships between museums and visitors, reinforcing the concept of the museum as an interactive space.

Just before the internet boom triggered by the pandemic, The Art Newspaper conducted its initial analysis of museum social media followers. Now, the number of followers on major online platforms (Instagram, Twitter, and Facebook) for the top 100 most visited museums globally has been reassessed to observe the changes

during this unprecedented period. At first glance, the changes seem subtle. The ten museums with the most social media followers in 2019 remain in the same positions, though the growth rates within the top 10 differ. For a deeper understanding, a meticulous data analysis was conducted by the authors how in the following (The Art Newspaper Russia, 2021). Instagram proved to be the most significant platform for the top 100 museums globally, with the audience growing most rapidly. The combined number of museum enthusiasts on this platform increased by 13 million, representing a 30% growth. In comparison, Twitter's growth was 13%, and Facebook's was only 5%. The position of the Instagram as the most popular social network among museums surpasses Twitter. In 2021, the total number of followers for the top 100 museums was 54.4 million on Instagram, 51.5 million on Twitter, and 36.3 million on Facebook (acknowledging that Instagram is owned by Facebook). Beyond the top twenty, there are fascinating success stories. Italian museums, for instance, are experiencing a renaissance in the online realm. The Vatican Museums increased their followers by 53% to 365,000, and their Instagram audience grew more than sixfold. The Uffizi Gallery saw a 50% increase in social media followers to 762,000, with Instagram and Facebook contributing equally, even though the museum did not have a Facebook account at the beginning of 2020. Other notable successes on Instagram include a significant rise in followers for the Musée d'Orsay in Paris (over 360,000 new followers, totaling almost 1.3 million). The Reina Sofia Art Center in Madrid gained 57% more Instagram followers, and the State Hermitage Museum in Russia saw a 45% increase, reaching nearly 700,000 followers. The State Museums of Berlin, comprising 19 institutions, became 44% more popular, reaching 55,000 followers—a noteworthy achievement for a country where museums have traditionally been less active on social media (German museums rank 87th in the overall rating of the most active institutions on social media). In 2019, a newcomer burst onto the scene in the ranking of museums' popular social media platforms—TikTok. While many major institutions have yet to tap into this platform for short videos (none of the top 10 museums boast a substantial TikTok following), some have achieved tremendous success. For instance, the Uffizi on TikTok has amassed 70,400 followers, the Rijksmuseum in Amsterdam has 78,100, and the Palace of Versailles has 98,000. The Black Country Living Museum, a reconstructed industrial town from the early 20th century in North England, has 569,100 followers on TikTok. In 2020, TikTok recognized this museum's account as one of the top 100 in the UK, and The Guardian reported it as the most visited museum on TikTok after a thorough investigation. Table 1 resume the results here desaiBED.

Place in the ranking	Museum	City	Number of followers on social networks (Instagram, Twitter, Facebook)	Position compared to the previous year's ranking	Subscriber growth compared to the previous year, %
1	Modern Art Museum	NY	13 010 000	Without changes	5
2	Metropolitan Museum of Art	NY	10 243 000	Without changes	5
3	Tate Modern, Tate Britain	London	9 957 000	Without changes	7
4	Louvre	Paris	8 634 000	Without changes	12
5	Guggenheim Museum	NY	6 910 000	Without changes	3
6	Van Gogh Museum	Amsterdam	6 170 000	1	10
7	Gallery Saatchi	London	6 030 000	-1	3
8	British museum	London	5 764 000	Without changes	12
9	National Gallery	London	3 780 000	Without changes	12
10	Victoria and Albert Museum	London	3 674 000	Without changes	11
11	National Prado Museum	Madrid	3 168 000	Without changes	10
12	Pompidou Center	Paris	2 906 000	Without changes	7
13	Orsay Museum	Paris	2 902 000	Without changes	18
14	Whitney Museum of American Art	NY	2 582 000	Without changes	7
15	Center Getty	Los Angeles	2 283 000	1	11
16	Los Angeles County Museum of Art	Los Angeles	2 227 000	-1	4
17	National Portrait Gallery	London	1 651 000	3	10
18	Gran-pale	Paris	1 643 000	-1	4
19	National Gallery of Art	Washington	1 599 000	-1	5
20	Reina Sofia Art Center	Madrid	1 579 000	1	12

Table 1 (Museums with the Largest Number of Subscribers on social media. Top 20) (The Art Newspaper Russia, 2021)

As we will see, the present work intends to prepare the basis for an extensive analysis on measuring the emotional state of visitors via social media. This is achieved through the definition of a specific methodology and a new model of emotional computing based on the acquisition of data in the physical field with a questionnaire administered to 100 students.

In the past decade, the study of emotional states and their categorization has spurred a wave of research into pattern recognition methodologies for the recognition of emotions, with applications in various domains, including the museum context. Researchers have increasingly employed diverse modalities as inputs for emotion recognition models, exploring channels such as facial expressions, paralinguistic cues, gestures, choice of words, and actions to gain insights into how individuals form impressions of each other's emotions (Jaimes et al, 2007). Multimodal integration emerges as a promising avenue to enhance the

accuracy of emotional classification, as it combines signals from multiple sources to mine patterns of emotions, thus providing a better understanding of sequences of affective events. Notable work by Philip Goldin and his team (Goldin et al, 2005) utilized functional magnetic resonance imaging (fMRI) to delve into the neural underpinnings of common emotions like amusement and sadness.

Furthermore, Gratch and Marsella have introduced Emotion and Adaptation (EMA) (Marsella et al, 2009), an innovative model integrated into virtual characters. These virtual characters, driven by EMA, play a pivotal role in making decisions and enhancing the learning experience. EMA serves as a comprehensive computational model of human emotion, aiming to elucidate the factors giving rise to emotions and their wide-ranging effects on cognitive and behavioral responses, particularly coping mechanisms. Notably, EMA has been successfully implemented in practical applications where individuals can interact with virtual humans using natural language, even in high-stress social settings (Gratch et al, 2012).

2. Methods and techniques

Importance of the research is to improve overall emotional assessment and feedback management techniques in cultural heritage institutions and to enhance the knowledge in developing systems interactively. This research is also important for building museums' awareness about the significance of visitor's opinions and emotional responses towards museum visit. It is beneficial for understanding the factors that influence the strength, valence, and variability of visitor emotions during cultural heritage learning experiences.

The research outcome is not only beneficial the researchers, but also the museums professionals and visitors. By providing a rich and detailed understanding of visitor emotions, it puts museums in a better position to design exhibits and programs that match visitor interest and learning goals. This research also will provide museums professionals with the detailed information about how people respond emotionally to their exhibitions and collections, allowing them to make realistic assessments as to whether further improvements are necessary. By making comparisons with other institutions and tracking the fluctuation of visitor emotions over time, museum professionals can also gauge the effectiveness of their efforts to enhance visitors' learning and emotional experiences.

Our research is dedicated to forging a robust methodology aimed at identifying and quantifying the emotional states of museum visitors through innovative

computational approaches. Drawing inspiration from well-established paradigms in emotional assessment, particularly within the realm of Intelligent Tutoring Systems (ITS), our primary objective is to craft a model finely attuned to the subtleties inherent in museum contexts.

The essence of our work lies in presenting a cutting-edge computational model meticulously designed to enrich emotional learning experiences within museum settings. Our model is geared towards seamlessly detecting and accurately quantifying visitors' emotions as they engage with virtual exhibits, leveraging the collaborative platforms of social media and streamlined data collection via Google Forms surveys.

We draw inspiration from Arroyo et al.'s work (Arroyo et al, 2009), which builds upon Ekman's classification of emotions (Ekman, 1992), discerning four fundamental emotional classes categorized along the axes of Emotivity and Affectivity. To gauge emotional states, we have devised a comprehensive questionnaire comprising twelve questions, with three dedicated to each axis. Responses are graded on a scale from -1 (indicating an extreme emotion) to 1 (representing the opposite extreme), with 0 denoting indifference.

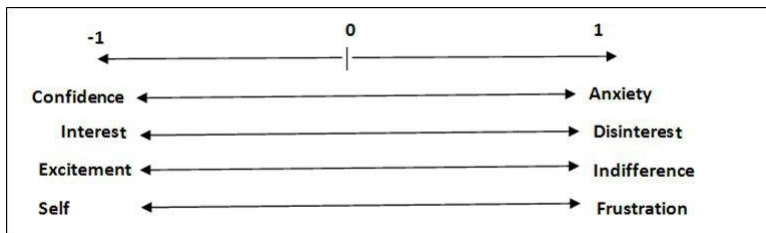


Figure 1 (Emotion Classes for Emotivity)

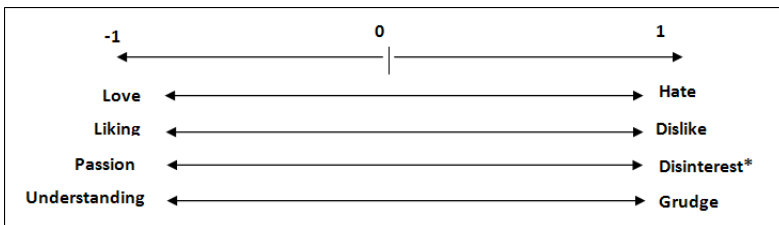


Figure 2 (Emotion Classes for Affectivity (* to distinguish the term when referring to passionate person who has a connotation sensual / sexual passion for the things that is synonymous with love))

Tailored sets of twelve questions are allocated to each emotional class to quantitatively assess emotions on a scale of 1 to 10. Scores are determined by averaging responses.

Our methodological framework analyzes Emotivity and Affectivity states as distinct four-dimensional spaces. This framework comprises two pivotal steps:

1. Step Level 1: Stimulus-Response: Museum visitors' reactions to emotional stimuli are evaluated through the questionnaire, yielding trivalent outputs (-1, 0, 1) that signify qualitative emotional responses.
2. Step Level 2: Quantitative Output Response: Parameters eliciting positive responses are quantified on a scale of 1 to 10 (or in percentage) via specific questions, focusing on dimensions such as anxiety, interest, and excitement.

Within the museum context, visitors' emotional states are delineated within a four-dimensional space ($S = (A, B, C, D)$). The questionnaire acts as a conduit to stimulate visitors with Learning Experiences (LE), thereby facilitating the pre-quantification of their emotional states. To ensure an effective assessment despite potential challenges, we adopt a balanced approach.

In sum, our methodology offers a structured approach to assess and quantify emotional states in museum visitors, furnishing valuable insights for enriching emotional learning experiences within museum settings.

3. Experimental results

Our computational model for enriching emotional learning experiences in museum settings yielded promising results, as demonstrated through a rigorous methodology and practical implementation.

To evaluate the model in a realistic context we have organized a virtual tour to Louvre Museum and we have conducted the analysis thanks to a work of interview on 100 students at Salerno University. Google Forms was applied in Instagram social media for input data acquiring. Here we report the results according to the model described in the previous sect.

3.1 Analyses of the answer on emotional questions

Based on 100 questionnaires, we obtained the following results.

Question №	Response	Analysis in %
1	0	85%
2	-1	66%
3	-1	72%
4	1	93%
5	1	79%
6	1	72%
7	-1	76%
8	1	89%
9	-1	58%
10	1	66%
11	1	69%
12	-1	67%

Table 2 (results of the answer of emotional questions)

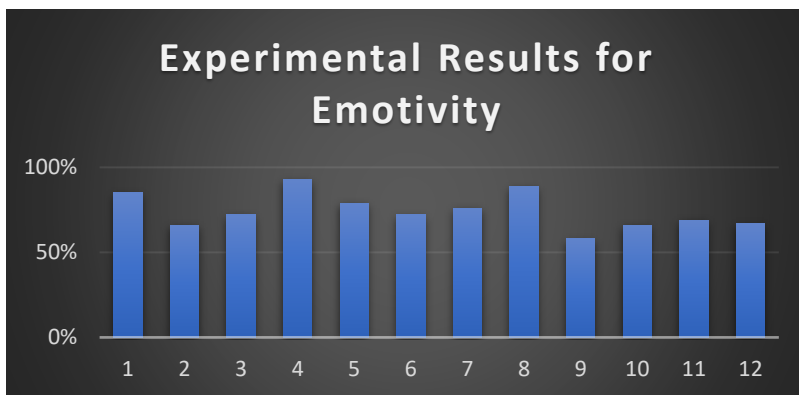


Figure 3 (Experimental results for Emotivity)

Here we find the statistical results about the emotive questions:

Mean	74,3%
Standard Deviation	10,4%
min	69,0%
max	93,0%

Table 3 (statistical results about the emotive questions)

3.2 Analyses of the answer on affective questions

In analogy with emotions, in this paragraph we use the methodology described above by considering the affections. Based on 100 questionnaires, we obtained the following results.

Question №	Response	Analysis in %
1	1	59%
2	1	64%
3	-1	58%
4	1	76%
5	1	74%
6	1	79%
7	-1	72%
8	-1	74%
9	-1	75%
10	1	74%
11	1	59%
12	1	72%

Table 4 (results of the answer of affective questions)

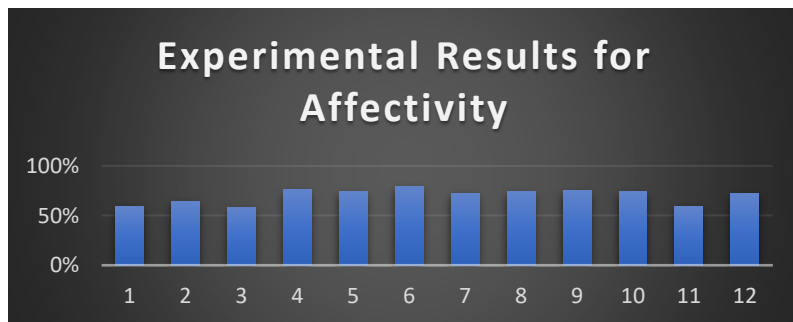


Figure 4 (Experimental results for affectivity)

Here we find the statistical results about the affective questions

Mean	69,7%
Standard Deviation	7,5%
min	58,0%
max	79,0%

Table 5 (statistical results about the affective questions)

Experimental Results for Affectivity and Emotivity

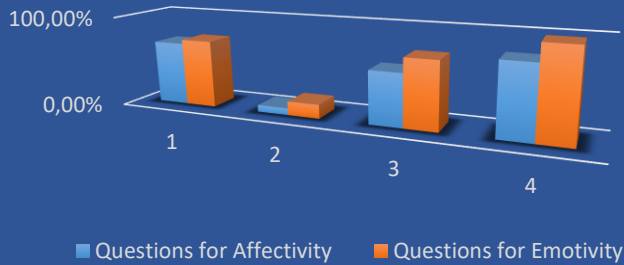


Figure 5 (Experimental results for affectivity and emotivity)

Where the “1” value – is related to the mean value, while the “2” value – is the Standard Deviation, the “3” value – is the minimum value and the “4” value – is the maximum value for emotivity and affectivity respectivity.

Here we find the percentages (%) of user’s reaction with respect to the emotional and affective states as represented in figure 3 and figure 4 respectively.

	Affectivity	Emotivity
1	69,7%	74,3%
2	7,5%	10,4%
3	58,0%	69,0%
4	79,0%	93,0%

Table 6 (statistical results)

The responses and analyses gathered from our computational model offer profound insights into visitors' emotions, preferences, and their significant impact on the overall museum experience. It's paramount to acknowledge the variability inherent in individual responses, highlighting the importance of addressing specific concerns raised in the feedback to foster an improved visitor experience.

Our findings reveal a notable trend: visitors exhibit heightened sensitivity towards emotional inquiries compared to affective ones. This observation is substantiated by the mean values, where emotions consistently score higher than affections. Moreover, our analysis demonstrates a greater responsiveness among visitors

towards positive emotions and affections in contrast to their reactions to negative ones.

To present our experimental results comprehensively, we utilize histogram forms for both emotions and affections. Furthermore, we provide detailed statistical measures including mean values, standard deviations, as well as minimum and maximum values for each category. This approach allows for a nuanced understanding of visitors' emotional states and their corresponding affective responses, contributing to the refinement of museum experiences tailored to visitor preferences and sensitivities.

Conclusions

Our research journey into the realm of museum experiences, augmented by emotional learning and affective computing, has unveiled significant insights poised to revolutionize visitor engagement. As we conclude our paper, we reflect on the transformative potential of our computational model and the implications it holds for the future of museum interactions. In conclusion, the paper addresses the inherent challenge of designing human-centered systems capable of intelligently responding to a visitor's affective state, especially in situations where determining emotions in human-to-human interaction may be complex. We emphasize the critical role of tailored feedback in the museum context and highlight the necessity for intelligent responsiveness to visitor emotions and the design of human-centered systems to navigate uncertainty, ultimately contributing to a positive and enriching museum experience. Furthermore, the validation of our model with experimental results from a set of 100 students underscores its potential for massive analysis in the future, leveraging social media platforms.

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