Museum Investigating Learning Experience Model Based on Mathematical Statistics

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Abstract. The integration of computer technology and digital media enhances the creativity of investigating learning experiences in museums. However, the advance in computer technology and multimedia has changed the relationship between information and audiences in an exhibition space. In this paper, the experience design method is used to improve the integration of computer technology and multimedia in museums. Furthermore, the experience design method is applied to the investigating learning experience of museum visitors. This study presents the author's analysis of museums' unique education environment with visitors' motivations as the center. A questionnaire was distributed to visitors to museum visitors to investigate the influencing factors of investigating learning during the visit. Excel 2010 and SPSS 25.0 software were used to process and analyze the collected data. The main statistical analysis methods are Kruskal-Waillis H test and $\chi 2$ test, and the test standard is $\alpha = 0.05$. Thus, an investigating-learning-oriented strategy model of museum exhibition is proposed. Finally, the model is verified by the case analysis, in order to realize the independent choice of the educational information content during the visit, likewise, an interactive relation between visitors and the information is proposed.

Keywords: Museum Experience · Mathematical Statistics · Audience Research Motivation · Experience Design

1 Introduction

With the emergence of various learning modes and the innovation of educational paradigms, the scope of museum education has been continuously expanded, and the interdisciplinarity has been enhanced. These have also become an important feature of the theoretical study of museum education in this period. However, although there is theoretical support in the integration of museum education and other disciplines, practicality should also be taken into consideration, and problems existing in educational phenomena should not be the only objective of discussion. Based on the experience design thinking, this paper tries to use museum resources to create the most content-rich research environment for as many people as possible.

Investigating learning in the museum means that visitors can learn within free-choice learning settings to meet their personal learning needs. As Nina Simon has said, the

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museum environment, as a research medium, is a ready-made place for discovery learning [4]. The learner-centered museum meets the diverse needs of all kinds of visitors, such as learning, leisure and entertainment, so as to encourage their free choice and self-construction. Thus it provides a feasible way for the establishment of its educational ecosystem.

The author takes visitors' research experience as the design object, and combines John Falk and Lynn Dierking's contextual model of learning [7]. As the main educational theoretical reference to explore the nature of museum experience and learning.

Secondly, quantitative data are collected through questionnaire survey, and the factors affecting visitor's study are analyzed according to the statistical data.

Therefore, under the visitors' learning motivation, an experiential research museum model is derived, and the model is verified by case analysis. It provides new ideas and methods for the development of museum public education in the future.

2 Contextualized Modeling of Investigating Learning in Museum

2.1 Contextualized Modeling of Investigating Learning in Museum

John Falk and Lynn Dierking's contextualization of museum learning points out that the learners' museum experience begins well before the actual visit and has a lingering effect after the visit [8]. The "story" of the visitor in the museum begins with the scholar outside the museum, followed by the scholar enters the museum and concludes after the scholar leaves the museum. The process of its experience is cyclical rather than linear. It establishes a contextualized model of learning (Fig. 1). These contextual models include: (1) personal context; (2) sociocultural context; (3) physical context; (4) time.

Theoretically there could be an infinite number of identity-related motivations for museum visitors; this does not seem to be the case. The reasons why people visit museums and how they describe their experiences after visiting can be summarized into a few basic types, which appear to reflect people's perceptions of museums' functions [6]. Based on John Falk and Lynn Dierking's research on visitors' research motivation, the author also attempts to summarize the five most common types of researchers, which are as follows: (1) explorers; (2) facilitators; (3) professional/ hobbyists; (4) experience seekers (5)

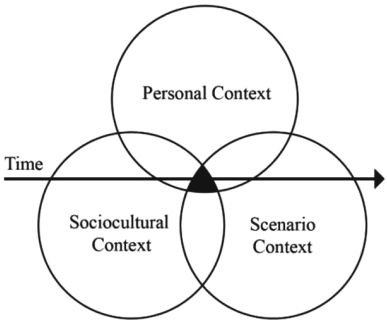


Fig. 1. Contextualized model of learning.

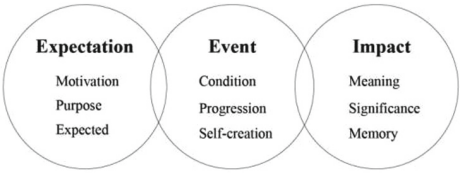


Fig. 2. Experience Design EEI Experience Model.

rechargers. In this dynamic time frame of exploration and learning, the experience design is visitors' needs-oriented, and its core content is constructed by visitors' behaviors. The design is considered based on the specific tasks, processes, and research experience of the visitor.

2.2 The Design Object is Based on the Vistor's Research Experience

In 2018, Professor Xiangyang Xin systematically discussed the essence of experience and its attribute model, namely the experience EEI model (Fig. 2), in the article "From User Experience to Experience Design" [10]. And put forward the experience design concept of "experience as design object". Specifically, EEI refers to the audience's expectation for an experience (Expectation), the choice of event development path (Event), and the reflection that the process gives the visitor, as well as the meaning of this experience is realized in the memory (Impact).

In order to use museum resources to create the most content-rich research environment for as many people as possible. The author used the experience EEI model to gain insight into the visitor's way of thinking, feeling and behavior, and throughout the strategy of the research organization. In this model, the visitors are included in the research experience design for museum. It is necessary to further explore the factors that affect the visitor's research experience in the current museum space.C. Refinement of influencing factors of museum research experience.

2.3 Refinement of Influencing Factors of Investigating Learning Experience

2.3.1 Research Method

This study mainly used a completely random sampling method. A total of 206 questionnaires were recovered from the surveyed population, of which 202 were valid, with an effective rate of 98.06%. After the questionnaire was collected, the data were cleaned and unqualified samples were excluded. Finally, Excel 2010 and SPSS 25.0 software were used for data processing and analysis. The main statistical analysis methods were Kruskal-Waillis H test and $\chi 2$ test. The test standard is $\alpha = 0.05$.

2.3.2 Statistical Description of Investigating Learning Data Samples

Through the analysis of the factors affecting visitors' "explore and study" in the museum, the following are the results obtained in this survey. The specific data sample information is as shown in Table 1.

Table 1. Basic Information of The Research Object.

Variable	Option	Quantity	Proportion
Age	19-30	174	86.1%
	31-65	24	11.9 %
	13-18	4	2.5 %
Education (Background)	Bachelor	144	71.3 %
	Master	35	17.3 %
	High-School	19	9.5 %
Job	student	144	71.3%
	Office Worker	44	21.7%
	Freelancer	14	6.9%

Table 2. The distribution of visitors aged 19–65 who are most impressed by the rhythm of museum exhibition content (person/%).

Variable		Leisure	Social	Study	Profession	Other	Total
Age	19–31	147 (84.5%)	51 (29.3%)	118 (67.8%)	50 (28.7%)	5 (2.9%)	174
	31–65	16 (66.7%)	5 (20.8%)	15 (62.5%)	3 (12.5%)	8 (33.3%)	24

Through the analysis of basic information, it is found that the age is mainly concentrated in 19–30 years old, and the main occupation is students, which fit the study's preset visitor. In view of the main visitor group, observing the influence degree of different indexes on investigating learning in the museum. This survey mainly analyzes two aspects of the influencing factors of investigating learning motivation---individual (internal) factors and environmental (external) factors. Among them, environmental factors are divided into people with information and people with space.

2.3.3 Analysis Results of Relevant Influencing Factors

(1) Individual (intrinsic) factors

By analyzing the motivation of visiting museums in different age groups, it was found that there was a statistically significant difference ($\chi 2 = 35.240$, $P = 0.000$), so the hypothesis of age-based experience classification is possible. However, considering the large difference in sample size between different age groups, the possibility of exaggerating the difference due to uneven age distribution cannot be ruled out. At the same time, considering that the visitors of the same age group have obvious motivational tendencies, and the difference in composition ratio is large. Therefore, the author gives priority to the classification of differentiated experience from the standpoint of identity motivation (Table 2).

Table 3. The distribution of visitors aged 19–65 who are most impressed by the rhythm of museum exhibition content (person/%).

Variable		Front section	Middle section	Back section	Total
Age	19–35	64 (36.8%)	78 (44.8%)	32 (18.4%)	174
	31–65	11 (45.8%)	12 (50.0%)	1 (4.2%)	24

Among visitors aged 19–65, most of them visit museums for leisure and learning needs. Those aged 19–31, the figures of these two items are 84.5% and 67.8% respectively, indicating that most visitors visit museums for the reason of "leisure" and "learning". At present, recreational and learning needs are still the main purpose of visiting.

(2) Environmental (external) factors: people and spaces

By analyzing the distribution of visitors in different age groups and the rhythm of museum exhibition content, it was found that there was no difference in this aspect between different age groups ($\chi 2 = 4.919$, $P = 0.554$).

However, when 19–30-year-old visitors visit the museum, (Table 3) they think the middle content is the most impressive, followed by the front content; while the 31–65-year-old visitors had a weaker memory for the information placed at the end, and has a deeper impression on the first half of the exhibition.

(3) Environmental (external) factors: people with spaces

Kruskal-Waillis H test was conducted on the distribution of different occupational groups of 19–65 years old in terms of the height of display, and it was found that the difference was statistically significant ($H = 13.836$, $P = 0.003$). It can be considered that different occupational groups aged 19–65 have different attitudes towards whether the height of display affects visiting experience. Therefore, it is necessary to create a dynamic and rhythmic museum display space and exhibition lines for the visitor. Thus, the visitor is led a bit further into the exhibition and becomes more interested in the exhibition content (Table 4).

Secondly, in the age range of 19–30 years old, visitors are most impressed by the contents of the exhibition in the order of objects, scene construction and model installations. In addition, in the age range of 31–65 years old, they are most impressed by the contents of the exhibition in the order of objects, scene construction and interaction methods. The object, as can be seen, is the most impressive way for the visitor to be impressed by the exhibition.

Table 4. The distribution of visitors aged 19–65 who are most impressed by the rhythm of museum exhibition content (person/%).

Variable		Object	Interactive	Scenario	Video	Model	Total
Age	19–35	117 (66.7%)	67 (38.5%)	113 (64.9%)	54 (31.0%)	73 (42.0%)	174
	31–65	17 (62.5%)	7 (29.2%)	11 (41.7%)	6 (25.0%)	6 (25.0%)	24

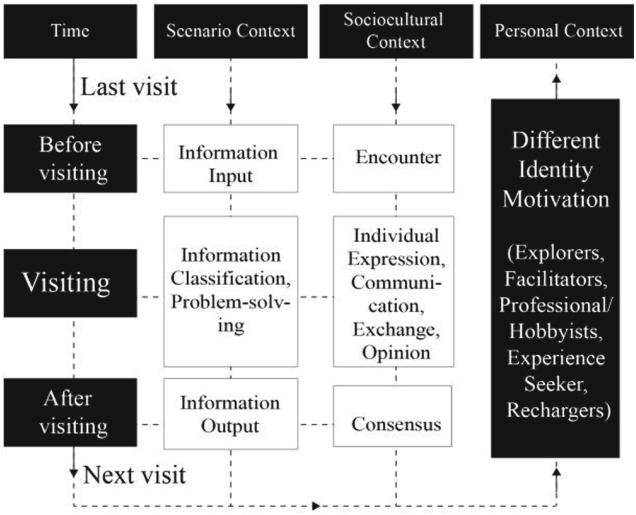


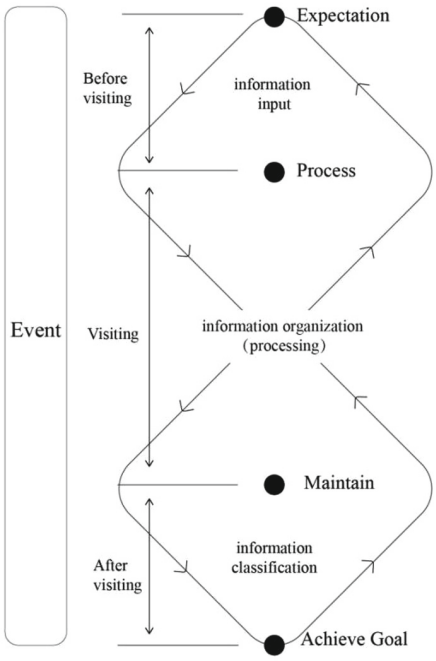
Fig. 3. Contextualized model of research experience.

2.4 Construction of Museum Experience Model Based on Audience Research Motivation

The author builds a preliminary model (Fig. 3) to represent the common and unique parts of the museum experience. This is a framework for presenting and organizing the complexity of the exploration experience, suitable for research experience strategies.

In general, the process of the visitors' investigating learning experience starts from the moment they decide to visit the museum, to the door of the museum, until out of the museum. The different expectations, experiences and knowledge of individuals brought in by each visitor, what they actually see and do in the museum, as well as the social and cultural context that the visitor is exposed to before, during and after the visit, all these factors affect the experience of investigating learning. Not to mention the overall perception of the museum and the value of a specific museum.

For the visitor, the museum visit process can be divided into three experience stages: before the visit, during the visit and after the visit. Based on experience design thinking, a model of museum visiting experience is established (Fig. 4), which shows the changing trend from dispersal to gathering and dispersing in the form of "information interaction".



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Observing the process of a museum visit from the perspective of identity motivation can yield important insights into how visitors construct their museum experience, including how they reflect on the visit through before, during, and after the visit (John H. Falk and Lynn D Dierking, 2005). In the whole investigating learning process, different research motivations present differently due to their different goals, and these research experience factors will also affect the research process of museum visits to varying degrees.

3 Construction of Experiential Exhibition Model Under Visitors' Motivation

Visitors are divided through identity-related motivations, and a "differentiated" investigating learning experience is set up during the visit. The author summed up three types of experiential learning methods, modes, and characteristics (Fig. 5). Based on these three main characteristics of investigating learning, the author suggested a few suitable exploring methods and exhibition forms.

Different models of visit experience under research motivation

Way of Experience	Experiential Learning Features	Investigating Learning Characteristics	For the Crowd
Problem-oriented and exploration	Start with problem-solving, and end up with self-learning.	Information Quantity ●○○ Familiarity ●●● Object Amount ●●○	Explorers
Gamification Object Theater	Using game as a support to assist exploration.	Information Quantity ●●○ Familiarity ●○○ Object Amount ●●●	Experience Seekers; Facilitators
Connective Knowledge Construction	Constructing personal and intellectual meaning in real situations.	Information Quantity ●●● Familiarity ●●○ Object Amount ●○○	Rechargers; Professional/ Hobbyists

Fig. 5. Different models of visit experience under research motivation.

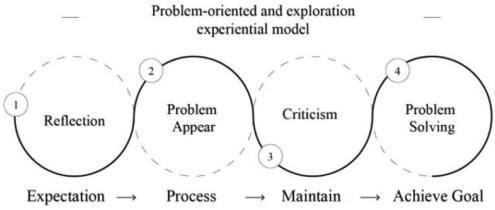

Fig. 6. Problem orientation and inquiry solution model.

3.1 Investigating Learning Experience Model Under Three Types of Visitor Motivation

According to the figure above, the visit experience model under the research motivation is the same as that developed in the previous section. Through the three steps of research, the objectives of each step of the three ways of research experience are further set.

3.1.1 Problem and Exploration Orientation Experiential Model

The "problem and exploration-oriented experiential model" is suitable for "explorers". Constantly arouse the curiosity of this type of visitors by asking questions and attract their attention. In the case of less information and less physical objects, by selecting "questions" with higher familiarity, the visitor can enter the process of investigating learning from the known to the unknown. Explaining problems to visitors in down-to-earth terms and inspire them to explore on their own.

John Dewey's the continuity of experience theory propose that each experience not only adopts something from previous experience, but also changes the nature of future

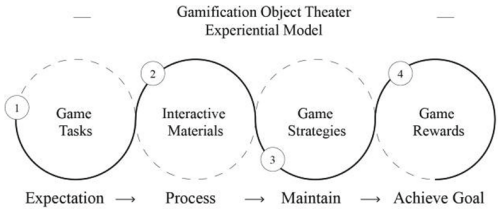

Fig. 7. Gamification object theater experiential model.

experience in some way [5]. He believes that the process of investigating learning is reflection, problem generation, exploration, criticism, and problem solving. Based upon his theory, the "problem" is the biggest motivation to stimulate this way of thinking. Therefore, it is necessary to cultivate the audience's inquiry ability in reflection and reaction. "Problem-based research" is a problem-oriented teaching method (Fig. 6), as well as a visitor-centered research method based on the real world.

3.1.2 Gamification Object Theater Experiential Model

The investigating learning experience of "playful object theater experiential model" is suitable for "experience seekers" and "facilitators". They both socially motivated and their satisfaction primarily derives from the mere fact of having "been there and done that". The difference is that "facilitators" are focused on primarily enabling the experience and learning of others in their accompanying social group. For this purpose, the object theater emphasis obtaining the information by playful interactive objects, and transforming the exhibition space into a theater. At the same time, "gamification" provides visitors with fun learning tools and easy ways to participate [9]. Gradually visitors will realize the purpose of conveying abstract concepts by participating. Not only can fulfill the purpose of "seeking", but there may also be gains of "experience and learning". Knowledge is aroused by interest and curiosity, and playful is an important value of museum games. The games with "objects" in the museum are diverse, rich and even uncertain, allowing the audience to "learn by playing" (Fig. 7).

3.1.3 Connective Knowledge Construction Experiential Model

The investigating learning experience of "connective knowledge construction experiential model" is suitable for "professionals" and "rechargers". Both of their purposes are to "learn", and the difference lies in the degree of acceptance of the information. Among them, "professionals" who feel a close tie between the museum content and their professional passion, they require professionalism of information; while "rechargers" are primarily seeking to have a contemplative, spiritual and restorative experience. This experiential model guides visitors to experience from the part to the whole. In the process of research, the information is constructed from "fragment" to "integrated" (Fig. 8), this process can make the visitor gradually built a "sense of achievement" in the acquisition of knowledge.

Albert Bandura also believes that the research process of self-monitoring is divided into self-observation, self-judgment and self-feedback. [1] Specifically, the audience

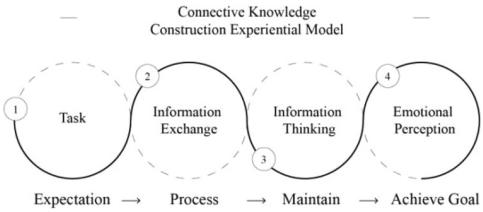

Fig. 8. Connective knowledge construction experiential model.

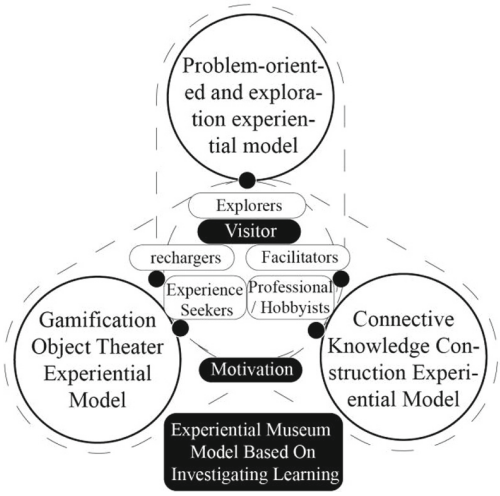

Fig. 9. Experiential museum model based on investigating learning.

is responsible for the process of self-learning, and combines the ideas in the research process with their previous knowledge. Interest and intrinsic motivation may be ways to promote further study and an active search for personal meaning [3]. The purpose of its research is to ensure the meaningful integration of new knowledge structures and existing knowledge structures, so as to achieve research goals [2].

3.2 Combined Case Analysis to Analyze the Feasibility of the Contextualized Model of Museum Research

According to the "Experiential museum model based on investigating learning" (Fig. 9) proposed in the previous chapter, these three different research experience methods are carried out in combination with cases, so as to describe the application of experiential museum strategies in more detail.

3.2.1 Problem and Exploration Orientation Experiential Model

Starting from the problem-oriented approach, the problem-based approach of information is re-introduced into the refinement and logical distribution of information centered

Fig. 10. Nature's seesaw education experiential exhibition.

Fig. 11. A gallery of paintings interacting with sculpture footage.

on the researcher, and the self-knowledge is completed from background-based reflection, question formulation, inquiry and final answer. In this process, the researcher's identity motivation as an "explorer" has obtained the desired goal. "Nature's Seesaw" is an educational experience exhibition held by Zhejiang Natural History Museum in 2020 (Fig. 10). The theme of the exhibition revolves around nature and metaphors it as a "seesaw" to express this ever-changing but dynamic balance of nature. Through the nature of the ecosystem formed by various organisms, the audience is guided to explore and understand the laws of nature and the importance of balance in a problem-oriented way.

3.2.2 Gamification Object Theater's Research Experience

Our knowledge is constructed by different stories and built by the physical environment. At the same time, our activities are also an important part of the construction of the environment and knowledge. How the audience strikes a balance between "interacting with the game" and "closely observing the exhibits", the Cleveland Museum of Art proposes the concept of "a gallery" (Fig. 11). The "object" is dialogued in a way of blending art and technology, including "sculpture lens" interaction, children's interactive installation, multi-touch collection wall, etc. There are more than a dozen interactive ways to display the stories of "object" that inspire the audience to explore. Audiences with different cultural backgrounds will have different perceptions and experiences of cultural relics.

Among them is a novel work titled "Sculpture Lens," which interacts by matching the viewer's facial expressions to the exhibits and modelling the poses of the exhibits. In addition, the museum has invited the audience to interact with 21 collections such as "gesture sensing and eye tracking", so that the audience can study and learn in interactive play. Facts have proved that the interaction method centered on the "object" can better deepen the audience's understanding of the "object".

Fig. 12. Siida-Sami Museum Experiential Space.

3.2.3 The Research Experience Method of Multi-dimensional Connection Construction

From the perspective of professionals, the experience of research needs to make more use of the audience's own senses and cultural tools to connect with the world. They have their own specific research and interaction methods, and experience interactive challenges from visual, auditory or tactile aspects. Multisensory experience is fundamentally a kind of synaesthesia, that is, the ability to experience multiple feelings at the same time. Things that truly integrate into the senses will be integrated into people's hearts, so that people can have a new form of resonance and understanding of exhibits in different cultural backgrounds.

The Siida-Sami Museum in Inari, Finland (Fig. 12), the theme of the permanent exhibition shows the survival strategies of life on the northern edge of the earth in response to nature, as well as the face of Sami culture. The exhibition longitudinally displays the causal connection and interaction between nature, traditional culture and contemporary life. There is a wall corresponding to each month around, there are backlit landscape photos on the wall, and many small exhibits are installed on the backlit wall. Huge photographs link up a shifting horizon, creating a bizarre set of landscapes around the space. The researchers turned 180 degrees, as if they had experienced a complete year. The annual cycle changes in lighting and color schemes to change visitors' moods. Make visitors pay attention to the space as a whole rather than the details. The museum transforms the visiting experience into an unpredictable nature roaming journey, where scholars can explore and discover countless hidden and different aspects during each visit.

4 Conclusions

This paper takes the learner-centered experiential museum as the design object, and summarizes it through qualitative experience design theory and learning contextualization theory. Based on the statistical data, collecting quantitative data, and analyze the factors influencing visitors' investigating learning. According to divers visitors motivation, models of experiential museum research are derived. The problem and exploration-oriented experiential model, the gamification object theater experiential model and connective knowledge construction experiential model are constructed. Combined with the method of case analysis for these three models, finding their relevant application cases to verify the feasibility of the model. This paper provides a methodological thinking for the experience design of future museum public education. However, this paper only puts forward

the theoretical conception of the museum experience model based on the visitors' motivations. In order to build this model for practical application, the following two problems still need to be solved. On the one hand, it is necessary to conduct in-depth application research of individual cases, and give experiential feedback to the model after application research. On the other hand, the corresponding technical support should be found, and the museum learning ecosystem should be established according to the future needs of the visitors' motivations. In the future, the above will be the focus of this research.

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References

1. Bandura A. Social foundations of thought and action: A social cognitive theory (Englewood Cliffs, NJ: Prentice-Hall, 1986).
2. Don Randy Garrison. Self-directed research: Towards a comprehensive model (Lifelong Education Research, 2018), p. 29.
3. Entwistle N. Styles of learning and teaching (Toronto: John Wiley, 1981).
4. Graham Black. The Engaging Museum: Developing Museum For Visitor Involvement (New York: Routledge, 2005), p. 56.
5. John Dewey (2005). How we think. Wenmin Jiang (Beijing: People's Education Press), p.250, 256, 261.
6. John H Falk, Lynn D Dierking. Museum Experience Revisited (Social Science Literature Publishing House , 2021).
7. John H. Falk, Lynn D. Dierking. The Museum Experience Revisited (Walnut Creek, Calif. : Left Coast Press, Inc., 2013), p.23–34.
8. John H. Falk. Identity and the Museum Visitor Experience (London and New York: Routledge, 2016), p.17-37.
9. Nina Simon. The Participatory Museums: Entering the Museum 2.0 Era (Hangzhou: Zhejiang University Press, 2018), p.23–24.
10. Xiangyang Xin. From user experience to experience design (Packaging Engineering, 2019), p.60–67.