Somatosensory Interaction of the Science Exhibition Based on Flow Theory

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Abstract. In order to improve the immersion and pleasure of users from science exhibition, a design method based on flow theory is proposed. Based on the flow theory, it proposes to set up clear science goals and sense of substitution for somatosensory interactive science exhibits, to maintain the unity of user skills and task difficulty, to maintain timely and effective feedback, to promote the guidance layer to maintain the continuation of the flow and other design methods, and use Jack simulation software for environment optimization research and analysis. Verification by the flow experience Likert scale proves that this method can greatly increase the probability and duration of the user's flow state, and effectively compensate for the shortcomings of neglecting the user experience in the design of traditional somatosensory interactive science exhibits. The example proves that the design of the somatosensory interactive science exhibits based on the flow theory can effectively improve the user's science experience and enhance the user's immersion and pleasure. This method has good universality.

1. Introduction
With the upgrading of technology, the popular science experience has been extended to a higher dimension, and its hardware and interaction methods have begun to appear in a variety of choices. In the design of somatosensory interactive science exhibits, how to embody the interactive advantage, whether the user's pleasure can increase with the change of technology, whether the experience process is linear, whether the environmental planning is reasonable, whether the evaluation system is established, lack corresponding methods to guide them. The flow theory is based on the psychological theory of cognitive psychology about mental state and interactive experience. By balancing challenges and user skills, it guides users to achieve the characteristics of high immersion and pleasure. Based on flow theory, the design of somatosensory interactive scientific exhibits, combined with Jack software, can quickly and accurately set up interactive process, build an interactive environment, keep user flowing and improve the popular science experience. Taken altogether We providing a new design method for somatosensory interactive science exhibits by this paper.

2. Exhibit structure
The digital science exhibits consist of three parts: information content, interaction mode, and user environment, as shown in Figure 1.
Figure 1. Structure of digital science and technology exhibition.

A large number of experiments have been conducted at home and abroad to combine emerging technologies and products, and it has been proved that the interaction mode composed of interaction scenarios and interaction technologies determines the user's direct experience. In the design of interactive scenes, Cabero [1] and others proposed to judge the educational situation, enrich the educational content by creating AR scenes to improve the immersion of students and strengthen the learning effect; Cai S [2] uses AR and Kinect to build the teaching content, through gestures Real-time interaction with the magnetic field can effectively improve learning efficiency. Experiments prove that the update of interactive scenes can stimulate the short-term interest of young user groups and enhance the efficiency of instant learning. However, Cabero and Cai S did not distinguish and verify multiple interactive technologies in the same scene. The advantages of visual stimulation after the scene were established also showed deficiencies in maintaining the user's high immersion, pleasure and control.

At the same time, domestic researchers tried to experiment with interactive technology as an entry point. Ma Huan [3] proposed a design method based on the integration of dynamic somatosensory interaction technology with multi-channel projection display, to achieve interactive freedom and dynamicity, and to improve the participant’s immersion; Li Hui [4] and others proposed a child attention evaluation system based on Kinect somatosensory interaction, which believed that somatosensory can effectively restore high immersion and natural Interactive mode, the test results under this condition tend to be true, positively determine the role of somatosensory technology in improving sensory sensation, behavior, etc. [5]; natural interaction mode is the main design direction, assisting interactive scene selection and Design is a way to effectively improve the immersion and pleasure of users in the learning and cognitive process.

The interaction method affects the user's perception and acceptance of the content. The design method based on the flow theory connects the content and the interaction technology without affecting the volume of the content, reconstructs the interaction scene, optimizes the user environment, and enhances the science experience.

3. Flow theory and experience

The flow theory is a psychological theory proposed by the famous psychologist Csikszentmihalyi about human psychological state and interactive experience [6]. Flow experience is an important concept of flow theory, which refers to a feeling of putting personal energy or "body and mind" completely in a certain activity [7], direct psychological experience and emotional feelings of immersion. Flow of mind, although it is only a temporary and subjective experience, is the psychological reason for people to continue to invest in this kind of activity [8]. When you enter the flow state, you will have a high sense of excitement and fulfillment, you will lose your sense of self-existence and time, and you will have a sense of participation from the heart and a desire to learn the experience.

User skills and challenges are two important indicators in the flow model. Csikszentmihalyi [9]
believes that the flow state will appear only when skills and challenges are balanced; when challenges are greater than skills, users often experience anxiety and skills are greater than When challenged, the bored mental state will be highlighted. In-depth analysis of the flow model to form eight user experience states, but there will be two unified presentations on the matching degree of their skills and task difficulty, that is, the combination of low skill level and low task difficulty, high skill level and high With the unification of skill difficulty, the former brings more indifference and the latter will produce flow experience. Only when the user has a subjective high skill level and perceives a difficult challenge will a flow state be formed, as shown in Figure 2.

Figure 2. The model of flow and depth refinement.

The formation of the flow experience will present 9 features [10]. Applying feature transformation to the design of somatosensory interactive science exhibits, it is divided into the control layer, guide layer and effect layer. The control layer is the basic part and controllable part of the design of somatosensory interactive science exhibits, which provides the possibility for the application of flow theory to somatosensory interactive science exhibits, and plays a decisive role in the final presentation of the flow experience; the guide layer belongs to the intermediate layer, which controls The degree is low, while rationally using the control layer to push the user's flow state to a high possibility, the role of the guide layer is to advance the opening point of the flow state and maintain a stable state; the effect layer is the performance result of the user's flow state, When the three are satisfied at the same time, the best science experience will be presented, as shown in Table 1.

| Csikszentmihalyi             | Somatosensory interactive popular science exhibits flow characteristics |
|-----------------------------|-------------------------------------------------------------------------|
| Clear and clear goals       | Control layer                                                            |
| Even valuable feedback      | Clear science goals and sense of substitution                            |
| Match skills with mission challenges | Instant and effective feedback                                         |
| The fusion of action and consciousness | Unity of user skills and task difficulty                                |
| High concentration of attention | Integration of interaction and consciousness                           |
| Potential sense of control  | Guide layer                                                              |
| Loss of self-consciousness  | High concentration of attention                                          |
| Change in time              | Effect layer                                                             |
| A sense of participation from the heart | Potential sense of control                                            |
|                             | Loss of self-consciousness                                               |
|                             | Change in time                                                           |
|                             | Highly spontaneous learning                                               |

4. Design method
The design structure of somatosensory interactive science exhibits based on flow theory is shown in Figure 3. Reasonable use of the control layer and the guidance layer can help users generate a flow experience.
Figure 3. Structure of somatosensory interaction of the science and technology exhibition.

4.1. Establishment of user experience environment
The establishment of the user experience environment is a prerequisite for the construction of interactive scenes and one of the main reasons for the selection of somatosensory interactive hardware. The user's actual environment determines the choice of the carrier of the somatosensory interactive product. Carrier and the actual environment also determine the proportion of reconstruction between the virtual scene and the real scene in the interactive scene. If there are many users in the experience environment and situation is complicated, the product carrier should take the no-carrying device as the main direction, and the interactive scene should be built with the screen imaging as the main technology to reduce the user experience pressure and reduce the equipment maintenance cost.

Jack software can provide human biomechanics models, quickly obtain and use human body data from various countries. Using Jack as the experience environment establishment layer, the optimal interaction area and interaction distance can be determined.

4.2. Clear science goals and sense of substitution
Science education is an informal education with a high degree of user spontaneity. As the main target user group of science popularization sites, teenagers are mature and not yet perfect. In the experience, they should clearly indicate the tasks, clues, information and interaction methods to the users to ensure that the goals are easy to understand and that the information given by the users is their own needs or task requirements. Completed.

The establishment of the sense of substitution is the opening point and instantaneous peak of the flow state of the somatosensory interactive science exhibits users, but the flow state obtained by the pure sense of substitution is very easy to lose, and it tends to be stable after repetitions. Analyze and design in the manner, manifestation and existence time of the establishment of the sense of substitution, which can make this flow state peak and remain relatively stable. When there are few somatosensory interactions in the exhibits and the interaction frequency is low, the user's current substitution manifestation should be increased. For example, the user's real-time skeleton model should be established and displayed for a long time; otherwise, the user substitution manifestation should be properly avoided to avoid high frequency and multiple actions.

4.3. Unification of user skills and task difficulty
Maintaining the unity of dynamic skills and difficulty is a design method that maintains high skill level and a high task difficulty. It is also the focus of the design method of somatosensory interactive science exhibits based on flow theory. Due to the large age range of exhibit users, there is a big difference between physiological and psychological maturity, and the design of the task difficulty needs to be divided. Combined with the characteristics of somatosensory interaction and human body model for information input, the current data terminal AI algorithm and pre-set combination are used to obtain the current user judgment, evaluate the user's psychological and physiological skills, and give the corresponding interactive task and interactive action difficulty level At the same time, the
information input feedback in the interactive process is used to judge and adjust the reasonableness of the current difficulty and balance the challenges. Suppose the accuracy of the user's action is \( A \), the standard interaction action is \( B \), the optimal completion time of the interaction is \( S_1 \) to \( S_2 \), and the actual completion time is \( T \), then the dynamic balance process structure can be introduced, as shown in Figure 4.

4.4. **Instant and effective feedback**
When the interactive action is completed, the user is quickly given relevant feedback, which can help the user to deal with the relationship between the interaction and the result, strengthen the learning and adjustment mechanism, reduce the somatosensory interaction lag, anxiety, and avoid interruption of flow.

4.5. **Advancement and promotion of the guidance layer**
The advancement and promotion of the guide layer can maintain and enhance the flow state that has been generated. The integration of interactive actions and consciousness, high concentration of attention, and a potential sense of control are the three indicators of the guidance layer.

An interactive action setting follows natural logical thinking, which is the difference and advantage of somatosensory interaction compared to touch interaction. Combining proprioception such as the movement of muscles and joint positions, body postures with vision and human brain, it evokes the mental model established daily, which is more helpful for the understanding and learning of popular science content. Due to the high dimension of the interaction scene, the non-linear process structure will increase the user's memory pressure and judgment ability. The experience process of somatosensory interactive science exhibits should be based on a linear structure to reduce unnecessary user anxiety and avoid task failures. Of users are frustrated.

At the same time, reasonable design needs to be made in terms of action frequency to ensure the necessity of interactive actions, maintain a high concentration of user attention, and avoid meaningless actions. In terms of control, it is very important to broaden the user's control limitations and develop skills. If the user cannot complete the task because of the low degree of freedom of control and the narrow field of vision, it will generate pressure and reduce the execution power, resulting in a state of flow. The loss of science and the destruction of the experience of popular science, and therefore unwilling to continue to try.

5. **Design case**
This article takes the case of the somatosensory interactive popular science exhibit "Life of Seeds" of
the Guizhou University Product Innovation and Digital Interactive Technology Research Studio.

First, set up a user experience environment for the Guizhou Science and Technology Museum. Due to its large user base and high liquidity, combined with the interactive actions extracted from the exhibits, projection imaging technology and Kinect equipment were selected as interactive hardware. Use Jack simulation to analyze user accessibility, visibility and posture [11]. Establish a human model of the age group of the target user group in Jack, rely on imaging technology to get the best interaction distance, and mark on the ground to delineate the best interaction range. After determining the content, environment and carrier, design the control layer. Connect Unity3D with Kinect, at the same time the background AI judges the input information, based on the height and gender to determine the difficulty, give the accuracy of the interactive activities, and then open the dynamic balance process structure; then the science goal is presented, that is, short-term tasks and long-term tasks, Show users short-term interactive action tasks such as seed selection, sowing, watering, fertilization, etc., and inform them that science knowledge can be obtained after successfully completing a series of long-term planting operations. After the user confirms, the image of the skeleton model captured by Kinect is optimized and projected into the interactive interface to establish a sense of substitution, which is the highest peak of the flow state at this moment.

The design of the propulsion layer is used to maintain the flow state. After collecting data on standard actions such as seeding and watering, a large number of target users of the product should be captured for the second time, combined with comparison, balance and optimization, to ensure that the action and consciousness are consistent and integrated, avoid deviation, and avoid frustration; Multi-frequency scene conversion will cause environmental distortion, so "Seed of Life" action feedback is established in the only scene, and the restrictions on the selection of objects and functions in the scene are appropriately relaxed, and timely and timely feedback is established to establish a sense of potential control and maintain user attention. Is highly concentrated, see Figure 5.

6. Design evaluation
To evaluate the users of the somatosensory interactive science popularization exhibits of the "Life of Seeds" Likert flow measurement table, see Table 2. There are 15 evaluation questions in the table, and the result adjective scale is divided into 5 corresponding levels and their scores can be provided, such as against very much (1 point), against (2 points), difficult to judge (3 points), agree (4 points)), agree very much (5 points), and collect statistics.

Table 2. Likert scale of flow.

| Serial number | The question                                                                 |
|---------------|-----------------------------------------------------------------------------|
| 1             | I know exactly what I want to do with this popular science exhibit           |
| 2             | My goal is clear                                                            |
| 3             | I can concentrate on what I do                                              |
| 4             | I didn't pay attention to what other people think of me during the experience |
| 5             | During the experience, I feel I can control what I am doing                 |
Some things seem to happen naturally (subconsciously enter certain pages; subconsciously make feedback actions)

1. I will naturally perform and complete the task
2. My ability is enough to cope with difficult and complicated operation situations)
3. The time seems to have changed during the experience (slow/speed up)
4. During the experience, I didn't realize that I was in the real world
5. I did not feel the pressure from the outside during the experience
6. In the process I can clearly focus on what is happening
7. I really enjoy the experience brought by this popular science exhibit
8. I know I'm doing well
9. I like to use popular science exhibits to cope with the challenge, I want to experience it again

A total of 120 questionnaires were distributed, and 114 valid questionnaires were collected. According to the score, users are divided into I (less than 45 points, no flow state), II (45-54 points, not sure whether there is a flow experience), III (55-64 points, have a flow experience but interrupted), IV (65-75 points, strong flow experience) Four states, see Table 3. The results show that this design method can effectively improve the immersion and pleasure of users.

| Sample number | Recovered number | Effective number | I  | II | III | IV | average value | Standard deviation |
|---------------|------------------|------------------|----|----|-----|-----|----------------|-------------------|
| 1-40          | 39               | 38               | 0  | 6  | 1   | 31  | 67.92          | 7.02              |
| 41-80         | 19               | 19               | 0  | 1  | 5   | 32  | 69.57          | 4.69              |
| 81-120        | 18               | 18               | 0  | 2  | 2   | 34  | 69.46          | 5.95              |
| total         | 117              | 114              | 0  | 9  | 8   | 97  | 69.00          | 5.89              |

7. Conclusion

Somatosensory interactive science exhibits based on flow theory have advantages in improving user immersion and pleasure, making it easier for users to enter the flow state, achieving efficient and pleasant science knowledge learning purposes, improving user science experience, and establishing a new somatosensory interactive science exhibit design model.

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