Research on the Design of Virtual Experiment Platform of Product Appearance Structure Based on Emotion Measurement

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Abstract. This paper mainly studied the influence of the design of virtual experiment platform on the users' emotional state and learning achievements, and explored the relationship between the three. The routine methods of emotion elicitation and measurement were studied. The emotion of users was elicited by different interaction design and visual design, and the emotion state of users was measured by SAM. Through the experiment, we got the conclusion that the design change will affect the emotion, and the emotion valence and the learning achievement are positively related, and provide the theoretical basis for the subsequent platform design.

1 Introduction

In recent years, practitioners have shifted from focusing on the user's effectiveness, efficiency, satisfaction and other usability aspects to the research of user's emotion, motivation, values and other fields. Emotional experience has gradually become the focus of user experience research, but there is no consistent result in the research of emotion in network platform learning. How to ensure the initiative of students' learning and improve the learning effect of students is the focus of network teaching platform research. Based on the course "appearance structure and material technology", this paper studies and realizes the virtual experiment platform of industrial product appearance structure. In the design and implementation process of the platform, the emotional state and learning achievements of users are mainly used as the design guidance of the structure disassembly experiment platform, so that the platform can induce users' positive emotions in visual and interactive design.

2 Emotion studies

Emotional state involves four aspects: cognition, feeling, physiological change and behaviour. Emotion model is divided into basic emotion model and dimension model. The dimension model uses two or more dimensions to describe emotion, which makes emotion research quantitative. Emotion induction and emotion measurement are the key contents of emotion quantification research [1].
2.1 Emotion induction method

The commonly used emotion inducing methods include venten inducing method, picture inducing method, music inducing method, movie inducing method, autobiographical memory inducing method and imagination inducing method\(^2\).

The above methods are suitable for the theoretical research and experiment of emotion, but not for the design research based on emotion. Therefore, this paper uses the method of emotion inducing material design to design two different platforms, and takes the visual design and interactive design of the platform as variables to induce emotion.

2.2 Emotion measurement method

Emotion measurement needs to indirectly measure people's emotions by measuring some emotion related quantities. Researchers mainly rely on self-report, physiological measurement, behavioural measurement and other methods to measure emotions\(^3\-^5\).

The emotion method used in this paper is Self-Assessment Manikin(SAM), which can measure emotion from two dimensions of emotion potency and arousal level. The SAM scale used in this paper is shown in Figure 1. The upper row represents emotional valence and the lower row represents emotional arousal level.

![Figure 1. Self-Assessment Manikin (SAM).](image)

3 Platform framework construction

The construction of the platform framework needs to complete the platform architecture design and system prototype production. On the one hand, we should focus on the interaction design and interface design of the system, on the other hand, we should focus on the information content structure and information content form of the system.

3.1 Platform architecture design

Determine the strategic level of the platform, including user needs and product objectives. The user needs to be able to grasp the knowledge of product disassembly structure and complete the experiment more easily through the platform. The goal of the product is to improve the efficiency and effect of teaching through the platform, enhance students' interest in learning, reduce the difficulty of students' learning knowledge and master students' learning state.

Design the scope layer of the platform, including platform functions and information. The content of platform scope layer is shown in Table 1. The structure layer of the design platform, including interaction structure and information structure, mainly designs the content and interaction logic of each page. Prepare the content materials of the platform, mainly including the collection of text and pictures of the platform and video production.
Table 1. Scope layer.

| number | Function        | Content                           |
|--------|-----------------|-----------------------------------|
| 1      | Authentication  | Login (Login page)                |
| 2      | Information display | Carousel chart (Home page)       |
| 3      | Teaching        | Structure and disassembly         |
| 4      | Experiment      | Experimental guidance and contents|
| 5      | Test            | Fill in and submit test questions |
| 6      | Experiment report | Fill in and submit the test report|
| 7      | information feedback | Message, question, etc          |

3.2 Platform interaction prototyping

This part mainly completed the prototype design and production of the experimental platform. In order to verify the impact of different designs on users, two different groups of framework layers and presentation layers were designed. Finally, the A and B interactive prototype platform as shown in Figure 2 were completed with Axure software.

Figure 2. A and B interactive prototype platform.
4 Evaluation experiment based on emotion measurement

Twenty college students aged 20-25 years were selected and studied. The 20 students were divided into two groups: A and B. The A and B platforms were used respectively to measure their emotional state during the experiment, and their satisfaction and achievement were measured after the experiment.

4.1 Experimental method

This research is a comprehensive design research, a single experimental method is difficult to achieve the purpose of the experiment, so a variety of experimental methods are used in the experiment. Including the control test method, experiment A and B were compared, the independent variables were interaction design and visual design, and the dependent variables were emotional valence, emotional arousal level, satisfaction and test results. Task method, set the experiment process as many small tasks, divide the experiment into several parts for research. Control variable method, each part of the experimental control variable is one of interactive design and visual design.

4.2 Data analysis

Cronbach's alpha was used to test the reliability of the data. The value of $\alpha$ is greater than 0.8, which indicates that the data has high reliability. As an indicator of reliability, the formula of $\alpha$ is as follows:

$$\alpha = \frac{n}{n-1} \left(1 - \sum S_i^2/S_t^2\right)$$

$\alpha$— reliability coefficient  
$n$— number of test items  
$S_i^2$— variance of scores of all users on question i  
$S_t^2$— variance of total scores of all subjects

According to the calculation method of Cronbach's alpha, the Cronbach's alpha of emotional valence of group A and B, task satisfaction and comprehensive satisfaction are calculated respectively, and the specific results are shown in the table 2. The $\alpha$ of all the data is greater than 0.8, the reliability test is passed, and the reliability is high.

|                                | Number of samples | Number of projects | $\alpha$ |
|--------------------------------|-------------------|--------------------|----------|
| Emotional valence A            | 10                | 16                 | 0.828    |
| Emotional valence B            | 10                | 16                 | 0.834    |
| Task satisfaction B             | 10                | 16                 | 0.856    |
| Task satisfaction B             | 10                | 16                 | 0.932    |
| Comprehensive satisfaction A    | 10                | 16                 | 0.865    |
| Comprehensive satisfaction B    | 10                | 16                 | 0.926    |

Single factor analysis of variance was used to test the difference between A and B groups of data, and the test results are shown in Table 4.
Table 3. One way ANOVA.

| Task  | F test (P) | One way ANOVA (P) |
|-------|------------|-------------------|
| Task 2| 0.450      | 0.022             |
| Task 3| 0.182      | 0.000             |
| Task 5| 0.412      | 0.023             |
| Task 9| 0.075      | 0.002             |
| Task 16| 0.490     | 0.035             |

There were significant differences in emotional valence between the two groups of A and B in tasks 2, 3, 5, 9 and 16 (F < 0.05, P < 0.05). It shows that the design change will have an impact on the emotion of the users.

Analyze the mean value of emotional valence of A and B groups, and get the line chart as shown in Figure 4. From the figure, we can see the emotional changes in the experimental process, which further shows that the design changes will have an impact on the emotion of the users.

![Line chart of average emotional valence](image)

Figure 3. Line chart of average emotional valence.

Correlation analysis was used to test the correlation of emotional valence and score. The results is shown in Table 5.

Table 5. Correlation coefficient of emotion performance.

|                | Average valence | Learning valence | Score    |
|----------------|-----------------|-----------------|----------|
| Average valence| 1.000           |                 |          |
| Learning valence| 0.935<sup>*</sup> | 1.000           |          |
| Score          | 0.864<sup>*</sup> | 0.837<sup>†</sup> | 1.000    |

The results show that there is a significant positive correlation between emotional valence and achievement, indicating that positive emotion can improve learners' achievement and negative emotion can reduce learners' emotion.

4.3 Conclusion

Through the analysis of one-way ANOVA, mean comparison, correlation analysis and other statistical methods to process and analyze the emotional valence, satisfaction, performance and interview data collected in the experimental process, the main conclusions are as follows:

1) The change of design will have an impact on emotional valence. The design approved by the users has a positive impact on their emotion, and the design not approved by the users has a negative impact on their emotion.
(2) There is a positive correlation between the emotional valence of the users and their scores. Positive emotions can make the users get better scores, while negative emotions can make the users get worse scores.

(3) System A is superior to system B in "overall" and "interactive operation", and system B is superior to system A in "interface style" and "interface color".

(4) The whole system is better, but there are still some problems in color, layout and interaction.

5 Summary and prospect

This paper studies the relationship between interaction design, visual design and users' emotional state, satisfaction and learning achievements in the process of using the platform through experiments, and draws relevant conclusions. It provides a theoretical basis for the follow-up improvement design and provides a reference method for the follow-up related design research. In the future research, we can consider using a variety of emotional measurement methods to measure the emotional state of the subjects, and study more design elements.

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