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Emotional Design of Children's Insect Science App with Kano Model Improvement

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Abstract: *In user requirements research, emotional design is a qualitative analysis of users' emotional needs, and in order to clarify the priority of emotional needs in design, it is necessary to introduce such an effective method of quantifying needs as the Kano model, which not only meets children's emotional needs, but also makes the design ideas clearer and more explicit. Taking the children's insect science education APP as an example, this study will first analyze the users' emotional needs based on the three levels of visceral, behavioral and reflective levels of emotional design, and then use the Kano model to categorize and sort the attributes of different emotional needs, so as to refine the key needs and guide the application of the corresponding children's insect science APP interface design. This study aims to provide new ideas for user needs analysis, and also hopes to provide practical references for the design of children's insect science APP.*

Keywords: *Emotional Design, Kano Model, Children's Science Education, Interface Design*

1. Introduction

With the progress of science and technology and the popularity of mobile devices, children's science APP based on the Internet and smart phones, making access to information more abundant and convenient, mobile applications for children to provide a more vivid, interactive and interesting learning pathway, has become an important way for children to obtain scientific knowledge and enlightenment.

When designing for children, Emotional Design is considered a key methodology. The child user group possesses rich emotional needs and psychological characteristics, and Emotional Design focuses on their affective and psychological experiences during usage. However, the emotional needs identified through Emotional Design remain qualitative in nature. How to meet these needs while clearly defining functional boundaries and optimizing design direction has become a pressing issue in this study. Therefore, this study introduces the Kano Model within the broader framework of emotional design to construct a design model capable of quantifying emotional needs, thereby determining whether such needs should be prioritised or excluded in functional development (Kano et al. , 1984). By combining these two theories, this study aims to explore a method model that can both meet children's emotional needs and clarify the priority of functionalities, thereby guiding the interface design of a children's insect science popularisation app.

2. Literature review

Emotional design is widely used in children's education APP. Zhu Yuan constructed an affective design framework and designed 'Animal Wikipedia' APP based on it, which significantly improved children's participation and learning interest by optimising the visual interface and interaction experience[1]. Tong Fang applied affective design to the rehabilitation APP for autistic children, improving the rehabilitation training effect through color, graphic and interaction design, and also expanding the scope of application of affective design in children's groups[2].

Kano model is equally valued in the field of children's education APP. Liu Qian used the Kano questionnaire to analyse user needs and guide the optimisation of the interface and functions of audiobook APP, and proposed practical improvement strategies[3]. The model is often used in combination with other theories, for example, Chen Bojun combined it with user journey mapping and LM-GM model to clarify the core needs of programming education APP for primary school students[4].

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Ying Xue et al. used the weight-optimised Kano model in the design of smart toothbrushes for preschoolers to improve the accuracy of requirements analysis[5].

It is worth noting that the combined application of Kano model and emotional design is emerging. He Ruiqing et al. combined it with the three principles of emotionality to develop cultural and creative products of Mianzhu New Year's Paintings that satisfy users' emotional needs[6], Chen Yunchao et al. designed toys for the elderly based on this framework. However, research on this combination approach in the field of children's education APP is still lacking[7]. This study will continue to explore the feasibility of their combined application in the field of children's product interface design.

3. Research Methodology

This study will initially analyse the functional needs of child users for insect science and classify them emotionally, and then apply the Kano model to quantitatively analyse the different need categories to arrive at a priority ranking, i.e., must-be, one-dimensional, and attractive requirements are the target needs, which will be developed into functional elements of the interface at the design stage, the model is shown in Figure 1.

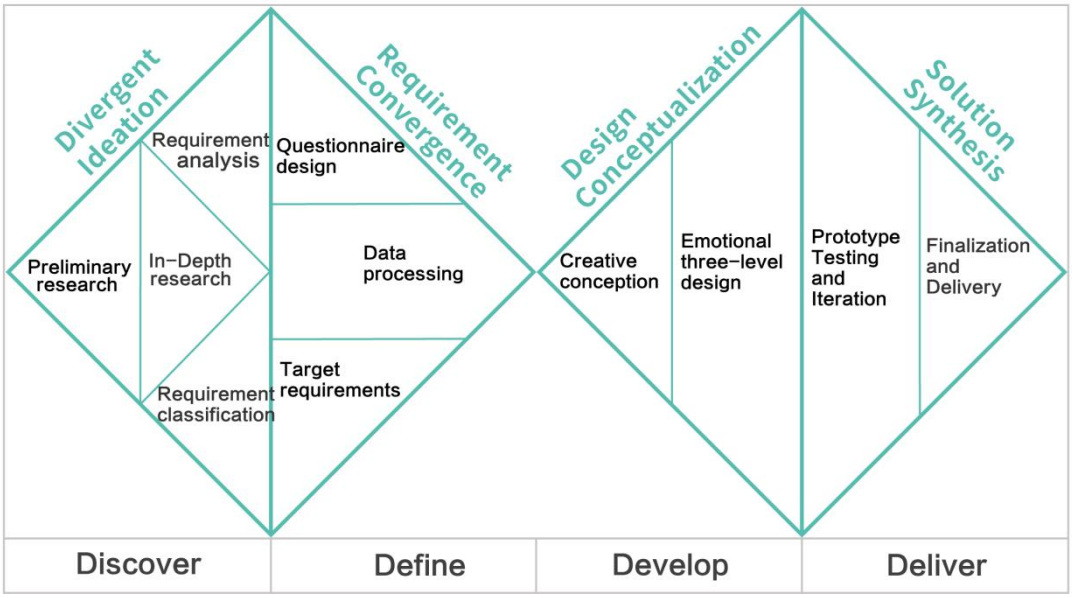

Figure 1: Model Construction Framework

3.1 User needs analysis

User Journey Mapping [8]visualizes service-related information, clearly illustrating children's interactions with the app, such as encountering an unknown insect outdoors, photographing it for identification, and adding it to a digital collection. Analyzing the entire process—pre-usage, during use, and post-use—reveals user needs, emotional curves, and opportunities for design, forming the basis for further research, as shown in figure 2.

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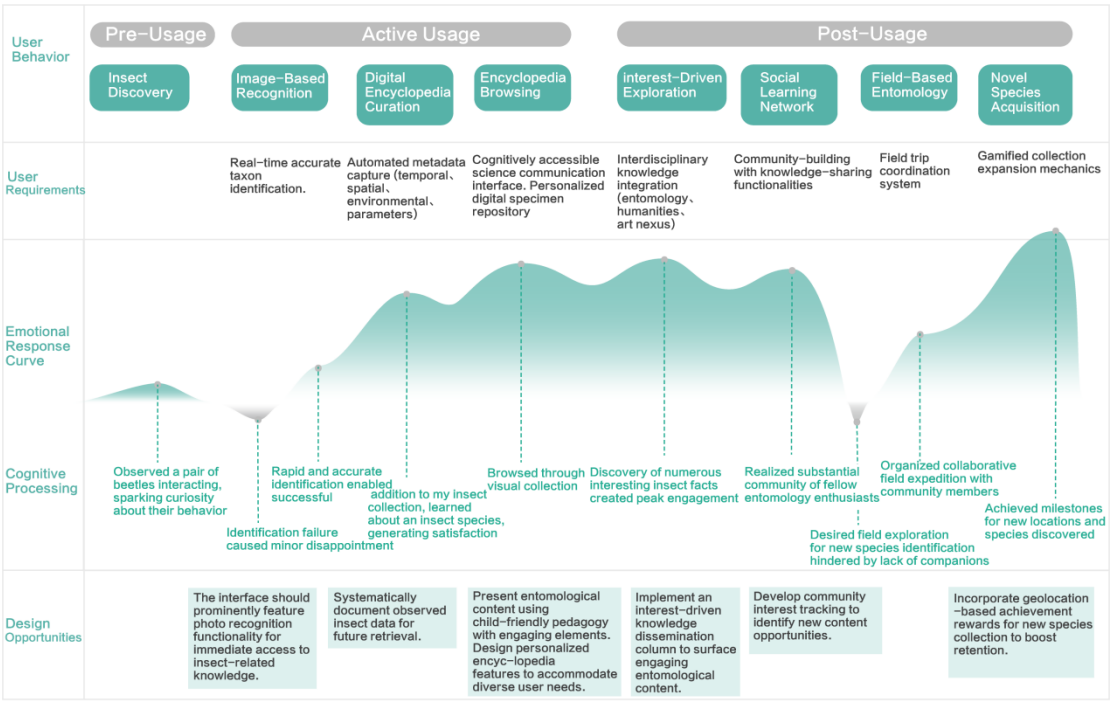

Figure 2: User Journey Map of Children's Insect Science Popularization App

3.2 Analysis of APP Emotional Needs

Emotional design consists of three levels, the visceral level has design needs such as interface layout, color scheme, icon design and so on. Behavioral level includes interaction flow, functional architecture, etc. Reflective layer is the emotional response of consciousness, emotion, understanding, etc. [9], such as the sense of achievement brought by the reward of gold coins.

Based on the research and user journey mapping analysis 13 specific needs were identified and the needs were further divided according to the three levels of emotional design, as shown in Table 1.

Table 1: Three Levels of Emotional Needs

Corresponding Level	Specific Function	Reference ID
The visceral level	easy to understand	A1
	beautiful interface	A2
	smooth operation	A3
The behavioral level	photo identification	B1
	science illustration	B2
	data logging	B3
	interactive friendship network	B4
	popular science classroom	B5
	interesting content recommendation	B6
The reflective level	Personalized illustration	C1
	reward mechanism	C2
	interface interaction	C3
	character guidance	C4

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3.3 Quantitative analysis of the kano model

3.3.1 Kano model questionnaire design

An editorial kano questionnaire was set up with questions on both positive and negative dimensions for each requirement, and corresponding to five satisfaction options, "Like " "Must-be" "Neutral" "Tolerate" "Dislike" 5 satisfaction options for users to assess their preferences.

3.3.2 Research Data Collection

The questionnaire was distributed to children aged 6-12 years old, adopting the online method. A total of 420 questionnaires were recovered, excluding the questionnaires with too short answering time, questionnaires with or without the same demand of "Like" or "Dislike", and some obviously unreasonable questionnaires, resulting in a total of 394 valid questionnaires with a validity rate of 93.81%.

3.3.3 Data Processing of Research Results

Based on the results of the above questionnaire survey, the horizontal and vertical table items are established with positive and negative questions respectively, and the positive and negative questioning results of each user, i.e., the degree of preference selection, are obtained and then calculated the proportion of this result in all the results, e.g., the user thinks that the interface operates smoothly is very much like it, while the appearance of lagging is disliked by 90, accounting for 22.84% of the total questionnaire proportion. Taking "smooth operation" as an example, the proportion of each pair of data for each of the two dimensions was calculated separately, resulting in a 5×5 data analysis, which is shown in Table 2[10], the obtained data results are classified and compared according to the Kano model results. The various categories are summed up, and all the functions are assembled into Table 2.

Table 2: Analyses of "smooth operation" data

	Option	If the interface exhibits latency, how would you feel?				
		Like	Must-be	Neutral	Tolerate	Dislike
If the interface operates smoothly, how would you feel?	Like	0.56%(Q)	2.03%(A)	17.07%(A)	30.70%(A)	22.84%(O)
	Must-be	0.07%(R)	0.27%(I)	2.13%(I)	3.86%(I)	2.81%(M)
	Neutral	0.05%(R)	0.17%(I)	1.54%(I)	2.80%(I)	2.03%(M)
	Tolerate	0.07%(R)	0.24%(I)	2.06%(I)	3.75%(I)	2.73%(M)
	Dislike	0.02%(R)	0.05%(R)	0.53%(R)	0.96%(R)	0.70%(Q)

M= Must-be Requirements, O= One-dimensional Requirements, A= Attractive Requirements, I= Indifferent Requirements, R= Reverse Requirements, Q= Question-able Requirements.

Table 3: Classification of the 13 emotional need attributes

Function Type Distribution	M(%)	O(%)	A(%)	I(%)	R(%)	Q(%)
A1	12.93	39.79	31.7	10.3	2.08	3.19
A2	4.31	11.35	55.69	21.17	4.6	2.55
A3	7.57	22.45	50.10	16.86	1.77	1.26
B1	13.88	30.8	30.32	13.66	4.96	6.38
B2	11.68	27.87	38.36	16.09	2.89	3.02
B3	10.33	22.15	39.61	18.46	5.21	4.32
B4	5.9	11.25	48.34	25.35	5.45	3.72

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B5	12.6	22.54	36.34	20.31	4.52	3.71
B6	13.76	29.97	32.61	14.97	3.82	4.86
C1	13.13	31.2	31.86	13.41	4.59	5.8
C2	14.23	31.98	28.56	12.70	5.32	7.2
C3	3.38	8.81	60.03	23.03	2.54	4.51
C4	4.75	12.74	32.02	19.38	6.04	5.04

In order to make the findings more precise, the analysis of Better-Worse coefficient is introduced. It's a measure of the extent to which a feature has an impact on increasing satisfaction (s_I) or eliminating dissatisfaction (Ds_I)[10]. Better represents the satisfaction when the user's needs are met, which is generally expressed as a positive value and is positively correlated with user satisfaction, Worse represents user satisfaction when needs are not met and is generally expressed as a negative value, which is negatively correlated with user satisfaction [9]. Taking "smooth operation" as an example, substituting the data in Table 3, the calculation of Better (*B*) and Worse (*W*) coefficient is shown in Equation (1)(2).

$$B = (A+O) / (A+O+M+I) \quad (1)$$

$$W=-(O+M) / (A+O+M+I) \quad (2)$$

The B coefficient is 0.75 and *the W* coefficient is -0.31 from equations (1)(2).

"Increase in satisfaction" and "Elimination of dissatisfaction" were calculated for each emotional need, as shown in Table 4.

Table 4: Emotional Needs Satisfaction Level and Attribute Table

Corresponding Level	Reference ID	Attribute	s_I	$\|Ds_I\|$
The visceral level	A1	M	0.75	0.31
	A2	M	0.72	0.17
	A3	O	0.75	0.56
The Behavioral level	B1	O	0.70	0.51
	B2	O	0.70	0.42
	B3	I	0.68	0.36
	B4	I	0.66	0.19
	B5	A	0.64	0.38
	B6	A	0.69	0.48
The reflective level	C1	O	0.70	0.49
	C2	A	0.69	0.53
	C3	M	0.72	0.13
	C4	I	0.65	0.25

A four-quadrant model is established with the average value of s_I and $|Ds_I|$ as the axis, i.e., the value (0.697, 0.367) as the origin, the first quadrant (B > 0.897, W > 0.367) is the One-dimensional

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Requirements, the second quadrant (B < 0.697, W > 0.367) is the Attractive Requirements, the third quadrant (B < 0.697, W < 0.367) is the Indifferent Requirements, and the fourth quadrant (B > 0.697, W < 0.367) is the Must-be Requirements.

From Fig. 3, it can be seen that the One-dimensional Requirements, including easy to understand (A3), photo identification (B1), science illustration (B2), and personalized illustration (C1), the Attractive Requirements, including popular science classroom (B5), reward mechanism (C2), and interesting content recommendation (B6), the Indifferent Requirements, including data logging (B3), interactive friendship network (B4), and character guidance (C4), the functionality and reference of Indifferent Requirements are lower and therefore are often strongly avoided during design[11], Must-be Requirements, including smooth operation (A1), beautiful interface (A2), and interface interaction (C3). Emotional requirements are ranked in the following order: Must-be Requirements > One-dimensional Requirements > Attractive Requirements > Indifferent Requirements[12]. The emotional positioning in design and research mainly focuses on the top three requirements. Indifferent requirements are of little significance.[13]

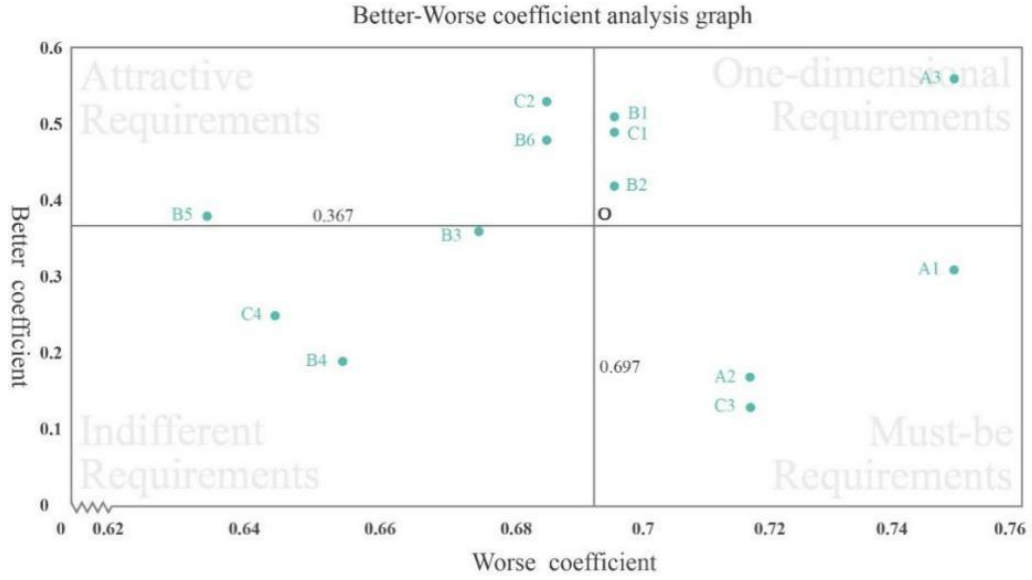

Figure 3: Four-Quadrant Analysis Diagram of Better-Worse Coefficients

To sum up, the direction of design and development has been basically determined, and the priorities of all the requirements to be developed are as follows: smooth operation > beautiful interface > interface interaction > easy to understand > photo identification > science illustration > personalized illustration> popular science classroom > reward mechanism > interesting content recommendation.

4. Results and Discussion

4.1 Visceral Level–Visual Design

This level addresses sensory impressions, corresponding to smooth operation (A1), beautiful interface (A2), and smooth operation (A3). Design elements include:

- Colors: Natural outdoor palettes for authenticity, bright hues for attention, harmonious schemes for comfort.
- Insect Illustrations: Realistic yet softened features (e.g., rounded legs, minimized sharp details) to reduce fear while retaining accuracy (e.g., *Anomala corpulenta* redesign in figure 4).
- Layout: Clear, intuitive interfaces with enlarged buttons for child-friendly use (Figure 5).

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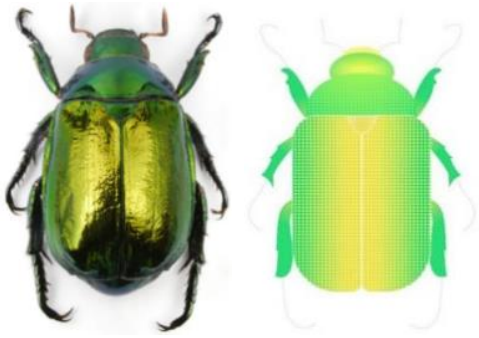

Figure 4: Example of Insect Image Redesign (e.g., Anomala corpulenta)

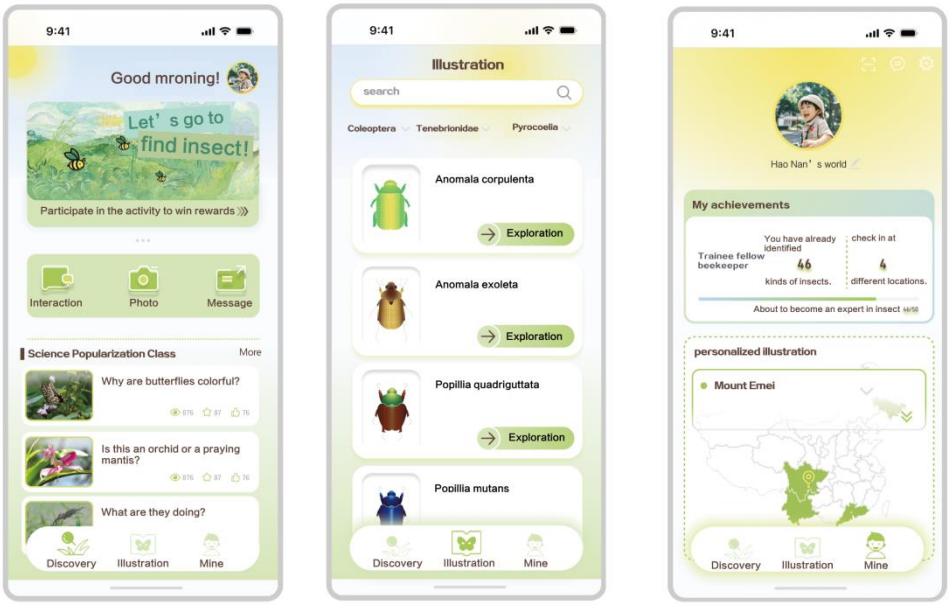

Figure 5: Interface Design Specifications

4.2 Behavioral Level–Interaction Design

This level focuses on usability, corresponding to photo identification (B1), science illustration (B2), popular science classroom (B5), and interesting content recommendation (B6). Design includes:

- Functional Architecture: Tree-structured information hierarchy for quick navigation (Figure 6).
- Interaction Flow: Photo ID on the homepage adds insects to "My Collection", unidentified species prompt user-posted queries. The "Encyclopedia" section organizes insects by taxonomy, offering detailed profiles. User achievements are displayed under "My Profile" (Figure 7).

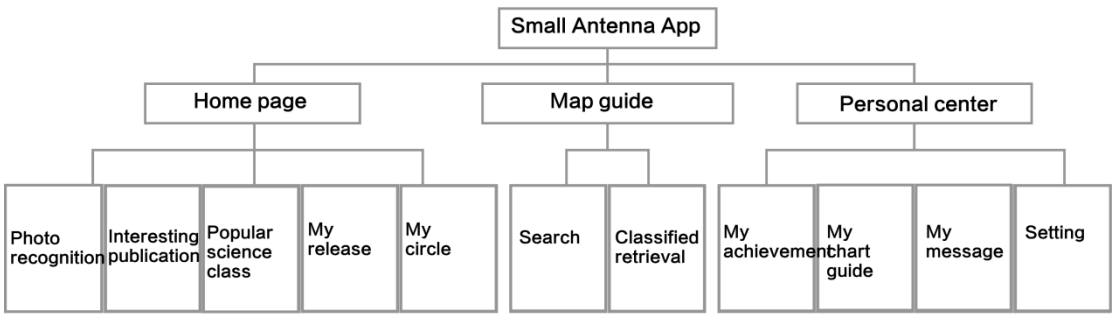

Figure 6: Functional Architecture Diagram

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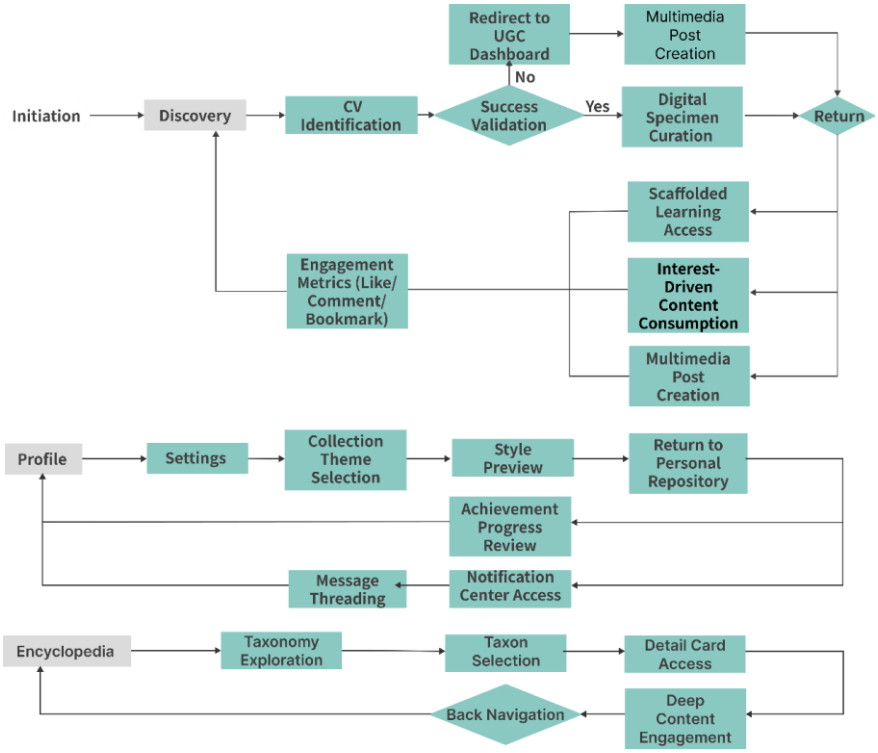

Figure 7: Interaction Flowchart

Figure 8: Achievement Reward System Demonstration

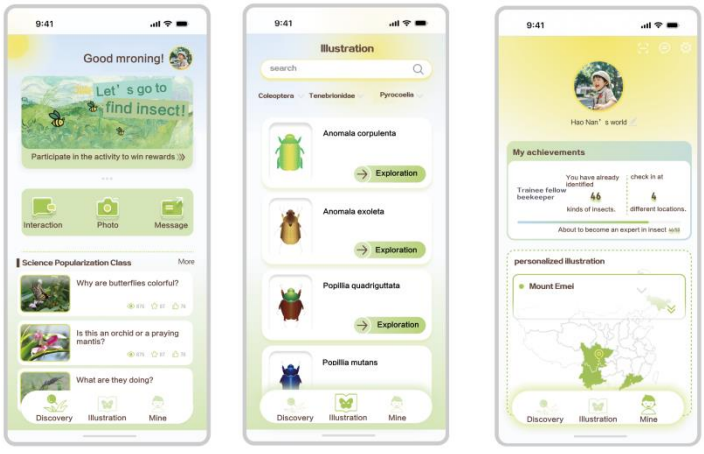

Figure 9: Personalized Collection Interface Designs

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4.3 Reflective Level – Emotional Engagement

This level fosters long-term emotional connections, corresponding to personalized illustration (C1), reward mechanism (C2), and interface interaction (C3). Design features:

- Rewards: Experience points and titles for discovering new insects or locations, enhancing achievement motivation (Figure 8).

- Personalized illustration: Themed by location, category, or color, catering to diverse preferences (Figure 9).

5. Conclusion

Emotional design's three levels provide a clear framework for children's science apps. The Kano model quantifies emotional needs, distinguishing must-be, one-dimensional, and attractive requirements to optimize functionality and avoid over design. This study offers practical guidance for insect science apps and a reference for other educational products. Future research could integrate child psychology and cognitive science to explore immersive features like personalized recommendations and social interaction.

In summary, emotional design is key to enhancing user experience, making knowledge dissemination engaging and warm. Through scientific requirements analysis and precise design, we can inspire children's scientific curiosity and exploration, laying a foundation for their growth.

Acknowledgements

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