



Development and Nurture System: Development and Its Application

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Abstract. Innovative talents are crucial for China's transformation into an innovation-driven nation. To develop innovative talents with modern core competencies, the educational evaluation system should transition from focusing solely on "scores and promotions" to a diversified system that values moral character, intelligence, physical health, aesthetic education, and labor education. To achieve this goal, the DAN Competency Assessment System, developed and implemented by a team of experts, integrates advanced psychological assessment techniques grounded in neuroscience and psychology. It capitalizes on the benefits of multimodal big data and artificial intelligence. The system can evaluate the psychological well-being of children and adolescents through customized assessments and offer personalized recommendations based on the assessment results. The ultimate aim is to foster the holistic development of every child.

Keywords: psychological evaluation system; ability assessment; Computerized assessment system; children and adolescents; educational informationization

1 Introduction

Childhood and adolescence are critical periods for the plastic development of the prefrontal cortex, responsible for higher cognitive functions [1]. Comprehensive exploration of diverse psychological development during childhood and adolescence reveals the laws and characteristics of growth and development in terms of physiology, cognition, emotion, and sociality. Psychological studies indicate that external behavioral manifestations do not always correspond directly to internal psychological and cognitive processes, as they can stem from various psychological motivations [2]. External behavioral manifestations are merely the tip of the iceberg, similar to what is visible above the water surface. A comprehensive understanding of a child requires analyzing the hidden depths with advanced psychological assessment techniques to

uncover their implicit psychology. Drawing on empirical research in neuroscience and psychology, assessments now prioritize internal psychological qualities and stable cognitive functions over external behavioral manifestations. This comprehensive approach aims to guide the cultivation of innovative talents and facilitate children's future development [3].

The widespread use of digital tools in psychological services has enhanced convenience, efficiency, and personalization, as well as introduced new opportunities and challenges to the mental health industry.

Numerous studies abroad have focused on competency assessment tools. Prominent computerized cognitive assessment systems include the Penn Computerized Neurocognitive Battery [4, 5,6], the Vienna Test System [7], the Cambridge Neuropsychological Test Automated Battery [8, 9,10], and the National Institutes of Health Toolbox Cognitive Battery [11]. While some computerized cognitive assessment systems have emerged in China, they are still in early stages of development. Nonetheless, current psychological assessment systems, both domestically and internationally, possess several limitations. Firstly, most existing systems solely evaluate specific cognitive abilities, leaving a fragmented understanding of overall cognitive capabilities. Furthermore, these systems neglect the influence of immediate emotional states and personality traits on test outcomes [12].

A team of experts from the Institute of Psychology, Chinese Academy of Sciences, Beijing Normal University, and Zhongke Xinzhi (Beijing) Education Technology Co., Ltd. analyzed the psychological and cognitive foundations of "morality, intelligence, physique, aesthetics, and labor" and developed a comprehensive evaluation framework, emphasizing four interconnected systems vital to children's future development. They translated the concept of "five educations" into specific, measurable, evaluable, and predictable indicators. They created the first scientific evaluation system in the country that focuses on identifying the comprehensive quality, abilities, talents, and cultivating potential of children and adolescents, known as the DAN Quality and Ability Evaluation System. The DAN system assesses the psychological development of children and adolescents, providing personalized developmental suggestions. It provides precise support for scientific guidance and overall development, which stimulates their inner motivation and self-improvement. Currently, it is being implemented in the market for children and adolescents.

2 Functional Design

The development of DAN System Version 1.0 began in 2021 and was implemented in 2022. To date, the system has evaluated over 50,000 adolescents nationwide, offering its services to various educational and social entities such as public schools, private schools, educational institutions, activity bases, government agencies/communities, public institutions, and social groups.

This section provides a comprehensive overview of the system, covering expert teams, user groups, key processes, the DAN system model, and page functions.

Figure 1 presents a functional diagram of the DAN system, illustrating its key functions and concepts.

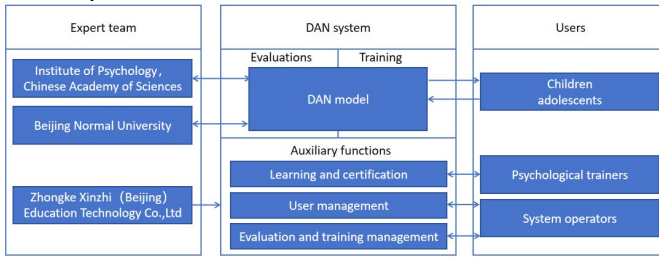


Fig. 1. Functional diagram

2.1 Expert Teams

Three expert teams support the DAN system, including teachers from the Institute of Psychology, Chinese Academy of Sciences, and the Faculty of Psychology, Beijing Normal University. Zhongke Xinzhi (Beijing) Education Technology Co., Ltd. is responsible for developing and operating the system.

2.2 User Groups

The system primarily serves children and adolescents while also accommodating parents, psychological trainers, and system operators.

Children and Adolescents(CA)

The system targets children and adolescents aged 7-18.

Parents

Youths require parental companionship and guidance.

Psychological Trainers(PT)

Psychological trainers are professionals in psychology who guide and interpret quality assessment reports. They must have relevant subject knowledge, complete online training, and pass assessments for certification.

System Operators

System operators perform functional operations to support business operations. They include employees responsible for system maintenance and expert teams.

2.3 Key Functional Processes

Taking CA's acceptance of services as a key process, the functional process of the DAN system is described in Figure 2.

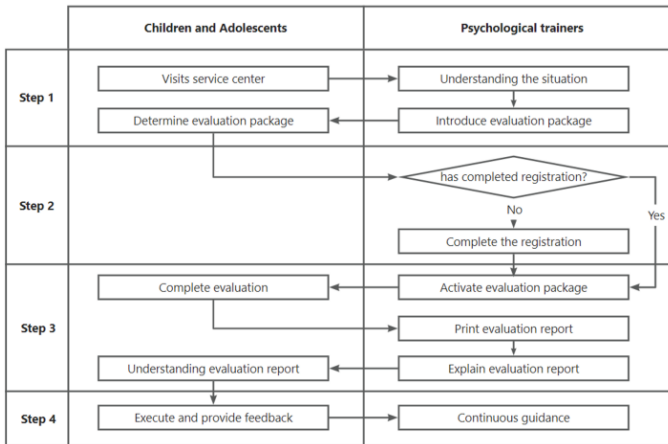


Fig. 2. Flow chart

Step 1: Initial Contact

The PT will greet and engage with all visiting CAs and their parents at the service center. This interaction aims to understand their circumstances and reason for the visit. Subsequently, the PT will offer tailored explanations of the assessment packages available on the system, assisting them in selecting the suitable option.

Step 2: Registration

CAs require an account to access the system's services. During registration, the PT will assign a username and initial password to CAs and collect basic information. Subsequent logins do not require CAs to register again for accessing the service.

Step 3: Complete Assessments

The assessment package must be activated by the PT for CAs to use a pad to complete their evaluations. Upon completion of the evaluation, the system generates an assessment report automatically. The PT has access to view, print, and provide explanations to CA regarding all the details in the report.

Step 4: Follow-up

After receiving the assessment report, CA and their parents can engage in targeted exercises in daily life based on the suggestions provided. By adopting the system's recommendations, CA's psychological qualities can be improved accordingly. CA and their parents can also consult or provide feedback to PT at any time, seeking positive guidance and advice.

2.4 DAN Model

The model encompasses assessment design, data collection, analysis logic, and advice based on the results. Consequently, the system divides the utilization process into five steps: profile creation, activation of the evaluation package, user assessment, score calculation via the backend intelligent system, and generation of an evaluation report.

Profile Creation

The system prompts users to provide basic information like name, age, gender, and contact details to create a personal profile. Based on the user's developmental needs, suitable evaluation packages are selected. For instance, a user facing learning difficulties receives a learning ability evaluation package, while someone unsure about their future career receives a career planning evaluation package. User profiles are securely stored in a database and continuously updated according to user behavior and feedback.

Activation of the Evaluation Package

The DAN system manages assessment content. Assessments are provided and maintained by expert teams based on factors like assessment package, usage scenarios, and trainer activation permissions. After editing the basic information and activating the assessment package, the PT can access and activate it during customer service interactions.

The system categorizes assessment packages into two primary groups: A Basic and B Analytical. The A Basic category consists of two secondary assessment packages: A1 Children's Core Cognitive Abilities and A2 Core Literacy. The B Analytical category includes six secondary assessment packages: B1 Children's Executive Function and Parental Behavior Habits, B2 Children's Self and Family Nurturing, B3 Core Learning Abilities, B4 Core Cognitive Abilities and Growth Mindset, B5 Adolescent Growth Challenges, and B6 Personality Independence and Career Development. Each secondary assessment package includes multiple evaluations. PT can perform targeted assessments of children and adolescents (CA) to understand their status in various related areas.

Figure 3 illustrates the assessment package's mind mapping.

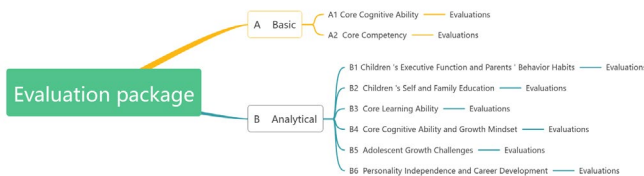


Fig. 3. Mind mapping of the assessment package

User Assessment

PT activates the suitable evaluation package based on the user's profile and needs. The system offers various evaluation packages (e.g., basic and analytical) to meet the assessment requirements of diverse users. The system presents specific evaluation questions or tasks from the activated package to ensure user comprehension of the evaluation content. The user responds to the evaluation questions or tasks based on system prompts, while the system collects their answer data or behavior data in real time.

Score Calculation via the Backend Intelligent System

Once evaluated by CA, the system preprocesses the collected user evaluation data through cleaning and standardization processes to guarantee data accuracy and consistency.

The system assigns scores to each evaluation item based on detailed scoring criteria provided by experts. These criteria are formulated using academic research and practical experience to ensure scientific and fair scoring. Each evaluation has its specific scoring criteria, determined based on academic research recommendations. As more data is gathered, the scoring criteria can be continually optimized and adjusted according to real-world circumstances.

The system computes the total score by considering the individual scores of each evaluation item in accordance with predefined weights and algorithms.

Generation of an Evaluation Report

The expert team provides scoring criteria and configures explanations for different score ranges within the system. Additionally, they develop growth advice based on the assessment scores.

The system generates an assessment report comprising evaluation scores completed by the CA. It provides the CA's basic information, explanations of assessment content, scores, interpretations, and growth advice.

CA can access pending tasks in the customer dashboard and must follow the advice to promote psychological growth. The webpage features daily reminders for each task. Upon receiving a reminder, CA clicks the execution button, completes the exercise guided by audio prompts, and submits feedback by clicking "Complete" on the task execution result.

2.5 Page Function

The DAN system consists of four distinct user interfaces: the Admin Panel, the Assessment Panel, the Client Panel, and the Certification Panel.

Admin Panel

The system operator, as an administrator, can log in using a username and password on any web-enabled device. Once logged in, a menu with three navigation op-

tions ("Client Management", "Assessment Management", and "Training Management") will appear on the left side of the screen.

Upon clicking "Client Management," a list page appears, exhibiting various client details such as name, phone number, gender, birthday, ID number, and address. The system operator can then modify client information, activate assessment packages, view, export, and print past assessment reports, and monitor training progress and execution.

Clicking "Assessment Management" enables the system operator to maintain assessment packages by adding or modifying assessments, updating descriptions, scoring criteria, and logic explanations. They can also assign ownership rights and establish usage conditions.

Clicking on "Training Management" enables the system operator to maintain training plans by adding or modifying trainings, setting requirements, implementing conditions, and more.

Assessment Panel

The evaluation system's application software is preinstalled on the company's multiple pads, enabling CAs to log in using their usernames and passwords. CAs are required to follow the instructions provided on the page and complete each evaluation step sequentially.

A PT must accompany CA throughout the entire evaluation process to provide tool operation guidance.

Figure 4 depicts the evaluation site.

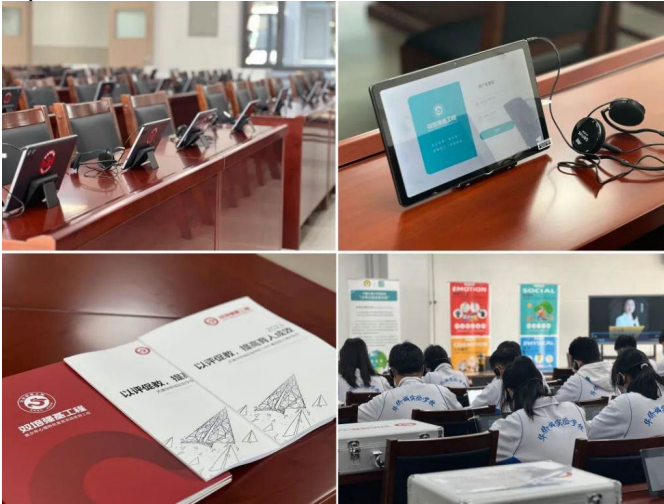


Fig. 4. Photo of the Evaluation Site

Client Panel

Parents can access their children's assessment results anytime through mobile phones or computer browsers. CA can fulfill training tasks based on task reminders and instructions.

Certification Panel

The DAN system supports the training of psychological trainers. Individuals interested in becoming certified psychological trainers can access the application page on the website using any web-browsing device. Once approved, applicants can log in to the system, complete project-specific online training courses, and participate in the assessment. Upon successful completion, they will receive certification.

3 Data Analysis

A psychological assessment report is generated by collecting multi-modal data from assessment devices such as PAD, smart bracelet, and edge computing terminal, using diverse paradigms for assessment, and conducting in-depth analysis with AI technologies like natural language processing and deep learning.

3.1 Data Receiving

The data reception module receives multi-modal physiological and psychological data from collection devices. The data reception function provides classified reception services for different modalities of physiological and psychological data, supporting the reporting of physiological data such as heart rate variability (HRV), heart rate, and blood pressure, as well as psychological data such as behavioral data and questionnaire evaluation data. The data is then uploaded to the application server at specific sampling rates, where synchronization of various physiological and psychological data takes place.

3.2 Data Fusion

The multimodal data fusion module of this system primarily synchronizes physiological data. The physiological data synchronization function synchronizes heart rate variability, heart rate, and blood pressure data in terms of time, aligns and calibrates data with varying sampling rates obtained during data collection, and outputs formatted data files following a prescribed structure. The overall data fusion analysis is a macroscopic statistical analysis of all data, including assessment personnel data, norm data, and exercise programs. This analysis can be further categorized into strategic, analytical, and operational types, offering personalized configuration schemes for different user types. It also provides visual data integration analysis charts such as personal assessment reports, comprehensive group analysis and comparison, and comprehensive analysis of psychological indicators.

3.3 Data Distribution

The data distribution function has two components: real-time data push channel and data storage channel. The real-time data push channel mainly provides the communication capability for the real-time monitoring platform to view real-time physiological data. It adopts the socket persistent connection mode to maintain data communication with the monitoring platform. The data storage channel is mainly responsible for establishing a data transmission channel with the server. According to different data types, the data storage channel pushes physiological and psychological data to their respective storage spaces in a targeted manner, facilitating the server's unified management of the data.

3.4 Data Feature Extraction

The data feature extraction module combines relevant literature and experimental conclusions from psychological and human factors engineering research on psychological state recognition to extract feature indicators based on psychological prior knowledge for different modalities of physiological and psychological data. Generally, the extracted feature information should be a sufficient representation or statistic of the raw data information. For example, for pulse data, it is planned to extract time-frequency domain features such as heart rate, R-R interval, low-frequency heart rate variability, high-frequency heart rate variability, and the ratio of high to low-frequency heart rate variability, as well as descriptive statistical indicators such as pulse amplitude, first/second derivative, and their mean and variance.

4 Application Case Examples

4.1 Personal Application Case Examples

Initial Contact and Information Collection

Student A had excellent grades in primary school but experienced a sharp decline in middle school.

Assessment Package Selection and Results

To understand the reasons for Student A's declining grades, we recommended the A2 Core Competency Evaluation Package. The assessment content includes cognitive abilities, emotional stability, personality, parent-peer relationships, and physical health.

The assessment results showed that Student A had high cognitive abilities and strong learning abilities, but had tense relationships with parents, leading to emotional instability and certain mental health risks such as anxiety and depression.

Based on the initial assessment results, we suspected that there were other factors affecting their learning status. Therefore, we also recommended the B3 Core Learning Ability Evaluation Package, which includes executive functions, inhibition control,

working memory, cognitive flexibility, learning motivation, and learning methods and strategies. Through the B3 assessment, we found that the root cause of Student A's learning problems was a lack of deep learning motivation.

Growth Advice

Parents should change their educational approach and have open communication with their child using positive communication methods, following the principles of proximal development. They should collaborate with their child to establish a learning plan. At the same time, encourage the child to pursue their interests, actively stimulate their learning motivation in daily life, and enhance their confidence and self-efficacy. When facing setbacks, appropriate attributions should be made.

Follow-up Feedback

According to the parents' feedback, one month later, Student A's overall grades in six subjects showed significant improvement.

4.2 Group Application Case Examples

Research Subjects

We randomly selected 39 second-year students from a middle school in Tianjin City, including 21 boys and 18 girls.

Research Tools

We used a customized specialized PAD as a device for collecting psychological indicators.

Indicator Selection

In order to achieve the goals of early identification of top innovative talents, diversified comprehensive evaluation, and early discovery of adolescent mental health risks, we selected six important indicators from the perspectives of ability, motivation, learning methods, and emotional stability. These indicators include core cognitive abilities, executive functions, learning motivation, learning methods and strategies, and emotional stability.

Assessment Results

Based on the group data analysis of the report results, the following conclusions can be drawn. These data provide scientific support for formulating student development plans.

Core cognitive abilities are important indicators for early identification and selection of top innovative talents. Due to sample size limitations, the differences in core cognitive abilities between different academic performance groups are not significant. However, based on previous research data, core cognitive abilities have become a

consensus in the academic community for predicting future academic and occupational performance. Core cognitive abilities are widely recognized as criteria for selecting top innovative talents both domestically and internationally.

Learning motivation, learning methods, and executive functions are key factors influencing students' academic performance. Based on the current sample data, there are significant differences in learning motivation, learning methods, and executive functions between students with good and poor academic performance. In other words, students' level of interest in learning, willingness to learn, learning efficiency, and their ability to inhibit internal and external interference, solve difficulties, and achieve goals will affect their academic performance. In order to improve educational outcomes and students' academic performance, targeted personalized training can be conducted based on each student's specific situation, by enhancing their interest in learning, improving their learning methods, and developing their executive functions.

Learning motivation, learning methods, and self-efficacy are closely related to mental health. From a psychological perspective, students' mental health is closely related to their learning motivation, learning methods, and self-efficacy. For students who have no interest in learning, are not good at learning, and feel helpless in learning, they are at greater risk of mental health issues. In the subsequent mental health education process, stimulating students' interest in learning, equipping them with certain learning methods and strategies, and enabling them to have a sense of control over their learning may help reduce the occurrence of psychological problems. Additionally, from a gender perspective, females face a greater risk of mental health issues compared to males.

5 Technical Implementation

The system's architecture utilizes Linux, Nginx, MySQL, and PHP to offer an efficient, reliable, and scalable solution.

The Linux operating system serves as the foundational platform, offering a stable, secure and abundant ecosystem of open-source software and tools. Nginx acts as both an HTTP server and a reverse proxy, providing high performance, low latency, and high concurrency to handle multiple client requests. As a relational database management system, MySQL offers robust data storage and processing capabilities, supporting transaction processing and complex queries. PHP, a server-side scripting language, boasts efficient performance and a wealth of development libraries, facilitating rapid web application development. This technical architecture is advantageous for its flexibility and scalability.

6 Conclusions

The DAN system is based on the basic theories of developmental psychology and is designed to track the quality and abilities of children and adolescents aged 7-18. It focuses on four dimensions: cognitive, emotional, social, and physical. It generates over 60 core indicators to evaluate the psychological qualities of children and adoles-

cents comprehensively. It provides a solid foundation and precise support for guiding and promoting the comprehensive development of children and adolescents. Through collaboration with schools, educational institutions, government agencies, communities, and other entities, it promotes synergistic development across multiple industries and facilitates the transformation of the psychological industry towards intelligentization.

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