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Constructing a Family-Support Community for Children with Special Needs in the Intelligent Era: An Integrated Path of Affordable AI and Home-based Visiting Teaching

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Abstract: In the intelligent era, family support for children with special needs is evolving from "kin-based mutual assistance" to a multi-agent community of "family-school-community-technology". Targeting prominent pain points for families of children with special needs, including costly professional services, low-frequency home-based visiting teaching, difficulties in generalizing interventions at home, and severe digital divides, this paper proposes building a community-support system underpinned by "affordable AI". Lightweight large-scale models, multimodal perception, generative intervention content and a closed-loop system for home-visiting teaching are embedded into daily household routines to establish a low-cost, replicable and humane family-support community. This paper systematically sorts out the practical applications of affordable AI in screening and assessment, Individualized Education Program (IEP) generation, home-based training, coordination for home-visiting teaching, and parent empowerment. Drawing on case studies such as the "2-square-meter Home-based Rehabilitation-Education Space" in Yuhang District, the "Star-Future" system developed by Central China Normal University, and the "Shi Run Kang Yue" large-scale model from Chongqing Normal University, this study puts forward an o perational mechanism of "AI-assisted lesson preparation before visits-human-machine collaboration during visits-family-accompanied practice after visits". Ultimately, a new paradigm for special-education governance featuring data-driven operations, professional oversight and inclusive technology is formed.

Keywords: Children with special needs; Family-support community; Affordable AI; Home-based visiting teaching; Individualized education plan; Digital inclusion

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1. Problem formulation: The three-fold disjuncture in family support for children with special needs

Caregiving for children with special needs is long characterized by high input, limited professional guidance, and weak multi-party coordination. First is the service disjuncture: rehabilitation institutions are mostly concentrated in urban areas, which imposes extremely high commuting costs on families in rural and border

regions. Students with severe disabilities can only rely on infrequent home-visiting teaching services. Second is the knowledge disjuncture: although parents spend considerable time accompanying their children, they lack intervention competencies. Problems such as "inability to teach" and "inaccurate interventions" hinder the generalization of learned skills. Third is the data disjuncture: hospitals, schools, visiting teachers and families maintain fragmented records. Individualized Education Programs (IEPs) are compiled largely based on experience and can hardly be dynamically updated.

The 15th-Five-Year Action Plan for Promoting High-Quality Development of Special Education, issued jointly by the Ministry of Education and six other governmental departments, explicitly encourages the development of special-education-oriented AI agents and explores artificial-intelligence-empowered home-visiting teaching. He Huizhong notes that the value of AI in special education lies in "matching learning pathways, providing adjustment references and satisfying diverse individual demands". Liu Xiaoming summarizes its strengths as "compensating for workforce shortages and enhancing professional capacity", while stressing that "technology strengthens human relationships rather than replacing them". Accordingly, the core question for constructing a family-support community becomes: how to deliver professional support through ordinary mobile phones, basic internet access and regular household spaces.

2. Connotation and access boundaries of affordable AI

"Affordability" goes far beyond low prices and encompasses four dimensions of tolerance:

(1) Economic affordability: free or low-cost mini-programs, open-source models, and public-interest computing resources; high-end equipment such as eye-trackers or brain-computer interfaces is not a prerequisite.

(2) Operational affordability: voice-interaction interfaces for elderly caregivers and less-educated parents without heavy requirements for literacy or learning curves.

(3) Scenario affordability: training can take place in a 2-square-meter corner, on a kang table or in a courtyard, eliminating the need for dedicated classrooms.

(4) Ethical affordability: local data processing, desensitized blockchain storage and revocable parental authorization.

(5) Recommended technical configuration: Android smartphones, WeChat mini-programs, lightweight end-side large-scale models, regular cameras and microphones, plus cloud platforms operated by regional special-education resource centers. Research from Chen Liangying's team has validated that AI-powered mobile mini-programs combined with knowledge graphs can support daily behavioral analysis and home-rehabilitation guidance for autistic children. Such solutions have been deployed across 29 provincial-level administrative regions nationwide.

3. Panorama of affordable AI-enabled support at the family level

3.1. Early-stage screening and daily observation

(1) Mobile-phone short-video collection: AI analyzes eye contact, gesture initiation, response latency and stereotyped behaviors and outputs risk-trend curves instead of formal diagnostic labels.

(2) Digitized home-use scales: automated visualization of simplified versions of M-CHAT, ABC and CARS assessment scales.

(3) Voice-log transcription: statistics on vocalization frequency, vocabulary growth and communicative functions (requesting, refusing, pointing).
(4) Digital journals for sleep, diet and emotional states: large-language models automatically identify triggering factors and prompt visiting teachers to adjust educational targets.

These tools shift passive "queuing for clinical diagnosis" toward continuous daily monitoring, which particularly facilitates early intervention for rural and multi-ethnic households.

3.2. IEP-assisted generation and dynamic adaptation

After inputting disability type, age, and baseline assessment results, the AI generates draft Individualized Education Programs: annual objectives are decomposed into quarterly goals, weekly assignments, and daily training cards. Visual schedules with graphic-text and voice broadcast functions are adapted for households with low literacy. Dialect-supported communication cards are generated via localized speech synthesis. After each home-visiting session, returned data enables the model to rearrange subsequent learning objectives and resolve the common gap between "written plans and real-world training practices". Practices at Shuangliu Special-Education School in Chengdu report around 45 % improvement in IEP formulation efficiency through digitization.

3.3. Home-based intervention training resource library

(1) Cognition and language: digitized Picture Exchange Communication System (PECS), AI-driven naming drills and generative situational dialogues.
(2) Social-emotional competence: custom-generated social-story picture books (e.g., scenarios such as "What should I do if someone snatches my toy?"), emotional flashcards and micro-video role-play exercises.
(3) Activities of daily living: step-by-step instructional videos for hand-washing, shoe-wearing and toilet training; cameras recognize completion of motor tasks.
(4) Behavioral support: ABC (Antecedent-Behavior-Consequence) logging for problem behaviors; AI proposes alternative behavioral strategies.
(5) Sensory-motor training: touch-screen games on ordinary screens partially replace costly sensory-integration apparatus, providing real-time feedback for limb movements of children with cerebral palsy.

The "Shi Run Kang Yue" large-scale model developed by Chongqing Normal University reduces rehabilitation costs by 30 %-50 % while boosting efficiency by 20 %-30 %, demonstrating that large-language models can simultaneously cut expenses and enhance precision.

3.4. Parent empowerment and psychological buffering

(1) AI-powered parent coaches offer immediate practical verbal strategies for real-life scenarios (e.g., when "the child lies on the ground crying for 10 minutes", recommendations follow the sequence: reduce stimuli → select alternative communication → conduct post-incident reflection).
(2) Three-minute daily voice micro-lectures with minimal reading burden.
(3) Key advice extracted from WeChat-group discussions and compiled into weekly household task lists.
(4) Self-assessment tools for parental burnout together with mindfulness audio resources to mitigate caregiver exhaustion.
(5) Community "digital-buddy" mechanism: university student volunteers provide remote technical debugging and data interpretation support.

4. AI-coordinated home-based visiting-teaching services

Traditional home-visiting teaching follows a pattern of "once-per-week delivery with no sustained follow-up". Affordable AI reconstructs this workflow into a closed-loop system covering pre-visit, on-visit and post-visit phases.

4.1. Before the visit: reducing teacher workload and enabling precise pre-planning

Teachers access cloud-stored archives with automated summaries of prior video, behavioral and physiological data. AI generates home-visit lesson plans, recommending appropriate training materials, practice rounds and risk warnings. Local rural resources (e.g., sorting corn kernels, walking exercises in courtyards) are integrated, avoiding blind replication of urban institutional curricula.

4.2. During the visit: human-machine dual collaboration and process documentation

While teachers deliver on-site instruction, AI records sessions and converts footage into short home-practice videos. Real-time captions and floating sign-language interpretations serve children with hearing or language impairments. Non-intrusive lightweight devices (e.g., headbands used in Yuhang's 2-square-meter rehabilitation space) collect attention metrics so teachers can adjust task difficulty on-site. Motion recognition helps cerebral palsy rehabilitation and corrects improper caregiving techniques used by parents. The Yuhang model covers 12 sub-districts, delivering 1935 home-based curriculum hours and more than 200 household guidance sessions, with quantifiable social-brain activity and 135 visible skill-development indicators.

4.3. After the visit: home practice and data feedback

Mini-programs push daily practice tasks (3 physical exercises plus 2 communication games). Parents upload short practice videos for AI-assessed completion and automated reminders. Abnormal emotional or behavioral events trigger early warnings to homeroom teachers and resource centers. Advanced learning packages are automatically generated ahead of subsequent visits, realizing the model: "teachers teach once; AI supports thirty-day home practice". The AI-enabled smart visiting-teaching platform at Xiang'an Qihang School in Xiamen implements this logic, integrating digital growth portfolios, dual-teacher collaboration and procedural monitoring.

5. Restructuring the family-support community

Children with special needs:

(1) Household layer: AI observation + parental practice + voice feedback
(2) Visiting teachers: on-site instruction + professional calibration + AI-assisted lesson preparation
(3) Schools/resource centers: IEP governance hub + data dashboards + teaching-research activities
(4) AI service layer: generative content, risk warning, multilingual translation, privacy-preserving computing
(5) Community, Disabled Persons' Federations, hospitals: policy subsidies, integrated medical-rehabilitation-education datasets, volunteer services

A functional community means more than setting up notification groups. Centered on children's growth data and empowered by AI as an interpreter, it translates clinical medical terminology into actionable parental

practices, transforms parental observations into evidence for teachers' decision-making, and converts teachers' practical expertise into reusable resources.

6. Adaptation strategies for local rural and multi-ethnic contexts

For regions marked by overlapping rurality and multi-ethnic diversity:

(1) Linguistic adaptation: AI speech and graphic cards support multilingual switching to eliminate comprehension barriers for parents.
(2) Spatial adaptation: training is delivered in courtyards, kang-heated beds or under grape trellises instead of dedicated rehabilitation rooms.
(3) Process adaptation: parents interact via voice broadcasts and graphic cards; teachers operate backend dashboards to align shared educational objectives across all stakeholders.
(4) Cultural adaptation: training materials incorporate local food, costumes, festivals and livestock-raising scenarios to improve skill generalization in real-life settings.
(5) Network adaptation: offline packages operate under low-bandwidth conditions; data is synchronized to the cloud only when internet connectivity resumes.

These measures align with existing research on integrating information technology into rural home-visiting teaching within the rural-revitalization framework: connectivity comes first, followed by contextual adaptation and professional quality assurance.

7. Ethical boundaries and risk governance

(1) No automated diagnosis: AI is limited to observational risk screening and training suggestions; formal clinical diagnoses remain medical responsibilities.
(2) No human-service replacement: emotional communication such as hugs and eye-to-eye comforting must be delivered by humans; AI acts as a "co-pilot".
(3) Privacy protection: facial and voice data undergo local desensitization; parents retain one-click revocation of authorization.
(4) Counter-algorithmic bias: training datasets must include diverse rural-urban and multi-ethnic samples to prevent evaluation standards biased toward urban children.
(5) Digital reciprocal support: avoid imposing extra burdens and anxiety on caregivers; AI shall reduce rather than increase household workload.

As research published in Chinese Journal of Speech and Hearing Rehabilitation Science emphasizes, multi-agent collaborative failures mostly stem from ecological imbalance. AI must be embedded within human-centered relationships instead of functioning in isolation.

8. Conclusion: From costly specialized services to daily accessible support

At its core, constructing a family-support community for children with special needs in the intelligent era does not aim to turn households into clinical clinics. Rather, it compresses professional expertise into ordinary daily-life contexts: mobile phones serve as assessment instruments, kitchens become training venues, visiting teachers function as connection nodes and AI acts as practice coaches.

Affordable AI enables continuous, personalized and dignified support networks for children with severe disabilities in western rural and multi-ethnic regions. Accordingly, home-visiting teaching evolves from humanitarian relief toward digitally-enabled basic public services.

Future research may apply Social Network Analysis (SNA) to characterize centrality among community stakeholders and quantify changes in family-school-community relational density before and after AI deployment, generating empirical evidence for advancing balanced special-education services in border and rural areas.

Disclosure statement

The authors declare no conflict of interest.

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