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Application and Evolution of LEGO Therapy in Social Intervention of Children with Autism from the Perspective of Inclusive Education

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Abstract: In the context of inclusive education, children with autism spectrum disorder (ASD) face significant challenges in social integration, while traditional intervention models have limitations in real teaching environments and stimulating children's intrinsic motivation. This paper explores the application and evolution of Lego® Therapy in this context. Lego® Therapy is based on the "Empathy-Systematization (E-S) Theory," which constructs a collaborative micro-society through precise role assignments such as "engineers," "suppliers," and "builders" in natural play scenarios, effectively enhancing the ecological validity of interventions. The study indicates that Lego® Therapy has evolved from initial standardized building blocks to a diverse ecosystem integrating sensory preference customization, high-tech robotics, and mixed reality technology. This evolution not only overcomes the bottlenecks of insufficient motivation and generalization difficulties in traditional interventions but also provides a forward-looking practical path for improving the substantive social participation of ASD children in regular schools.

Keywords: LEGO therapy; preschool inclusive education; children with autism; peer play interaction

Children with autism spectrum disorder (ASD) exhibit marked challenges in social integration, making them one of the most difficult and socially focused groups in inclusive education enrollment [1]. Current social intervention approaches for ASD children primarily consist of Applied Behavior Analysis (ABA), Social Skills Training (SST), and social storytelling. However, these traditional intervention models have increasingly revealed significant limitations in real-world inclusive education settings. At the individual level, children with autism often exhibit difficulties in initiating or maintaining conversations, understanding nonverbal signals, and sharing interests or emotions [2]. Traditional instructional methods and external reinforcement often lead to passive social responses driven by external rewards, failing to fundamentally stimulate their intrinsic social motivation. Secondly,

the marginalization of social goals [1]. Domestic classroom practices have failed to address the diverse needs of autistic students [3], lacking specialized intervention personnel and sustained professional support. Research indicates [4] that teachers' insufficient professional knowledge and skills result in children acquiring skills with limited generalization capacity, causing inclusive education to remain superficial rather than substantive.

Therefore, finding an effective support tool that can both accommodate the cognitive characteristics of children with autism and stimulate their intrinsic motivation in natural play situations has become a core issue urgently requiring response in current special education research. In this context, LEGO® Therapy has garnered widespread academic attention due to its high alignment with the ecological demands of inclusive education. This therapy ingeniously leverages the "systematic" cognitive style of children with autism, who prefer highly structured and predictable activities, transforming their "limited interests" into an intrinsic social engine. In a real inclusive classroom environment, by precisely assigning roles such as "engineer," "supplier," and "architect," it constructs a miniature society where collaboration is essential for children with autism and their typical peers, effectively overcoming the bottleneck of motivation deficiency and generalization difficulties in traditional interventions.

More importantly, as inclusive education practices deepen, LEGO therapy has evolved beyond a single technical level, undergoing a profound "application evolution." From basic standardized building kits to customized materials tailored to sensory preferences, and further expanding into a diverse ecosystem encompassing high-tech robots and mixed reality technologies, its intervention boundaries continue to expand. Therefore, examining and discussing the evolutionary process of LEGO therapy within the context of inclusive education not only helps reveal the underlying support mechanisms but also provides forward-looking practical pathways to enhance the substantive social participation of children with autism in regular schools.

I. Theoretical Connotation of LEGO Therapy

Lego therapy (LEGO® Therapy) was first proposed by American pediatric neuropsychologist Daniel LeGoff in 2004. It is a peer-mediated social skills intervention method that uses collaborative construction of Lego blocks as a medium. Theoretically, this therapeutic approach is primarily rooted in the "Systematic-Empathy (E-S) Theory" and Attwood's concept of "constructive application," advocating for avoiding forced correction of children's stereotyped behaviors. Instead, it utilizes their innate interest in specific objects as a medium to stimulate learning motivation [5].The therapy introduces precise role divisions of "engineer (describing instructions)", "supplier (finding parts)", and "architect (assembling hands-on)" within natural play scenarios. This interdependent collaborative framework creates a micro-society where synergy is essential to achieve goals, making sequential waiting, shared attention, problem-solving, and verbal communication "essential elements" for task completion, significantly enhancing the ecological validity of the intervention.[6][7]

II. Basic Application Model: Implementation of Standardized Interventions

（1）Core Mechanism: Role Swap

Engineers (reading blueprints and issuing instructions), suppliers (locating and delivering the correct building blocks), and architects (receiving blocks and assembling them). Participants regularly switch roles during collaboration, forcing everyone to practice social skills across different dimensions such as issuing instructions, listening, and joint attention. This mechanism can be modified through partial localization or special needs adaptation. For instance, a Malaysian study [8] simplified it to a "2 children + 1 teacher" configuration.

（2）staircase design

The intervention tasks follow a stepwise design approach from highly structured to less structured. Initially, standardized kits with visualized diagrams are mandatory, with difficulty levels precisely matched according to participants' age and fine motor skills.Once children have mastered the rules of cooperation, the task advances to a team-based scenario where they collaboratively conceptualize and build models without blueprints, thereby enhancing their ability to compromise and solve problems collectively [7][9][10].

（3）Standardized Lego kits and loose parts combination

In the vast majority of empirical studies, the most standard and widely used intervention tool is the combination of standard Lego kits and mixed physical building blocks. The team uniformly used standard drawing kits and freely assembled building blocks as core tools.Angelis[11] explicitly utilized the LEGO® Early Simple Machines (ESM) educational series in their study.[12]

This format represents the most practical foundational version in inclusive education, designed for collaborative play activities in kindergarten and early elementary school settings. It can be directly implemented as group games to help children with autism develop essential social skills such as initiating commands, active listening, and joint attention.

III. Evolution of Application: From Single Technology to Multiple Ecological System

（1）Co-design of New Toys Based on Sensory Preference

Since standard Lego primarily provides visual and singular tactile stimuli, it cannot meet the needs of all children with autism. Hijab[13] conducted a one-year collaborative design study, introducing customized multisensory "Bag-of-stuff" for tool innovation.The physical characteristics of the Hijab[13] experimental tool were entirely selected based on children's evaluations. For instance, in terms of color preference, both groups consistently favored black and blue; however, regarding tactile materials, the intervention center group preferred Velcro and fabric, while the school group preferred smooth textures. Nonverbal communication [13](e.g., repeating the Arabic word "eftah" to mean "open") also plays a central role when using these customized tools.

In inclusive education, children with autism exhibit significant sensory preference differences . Standardized Lego's single stimulus cannot meet the needs of all children. The multisensory material package allows Lego therapy to adapt to the individualized needs of inclusive education, enhancing the participation of children with autism who have different sensory characteristics.

（2）Expand into LEGO Robotics and Programming (LEGORobotics)

To cater to older children or those with a stronger interest in technology, traditional static building blocks have been upgraded to the LEGOMindstorms EV3 robotic kit, which integrates sensors and tablet programming [14][15].Raghavendra[15] conducted an 8-week intervention for autistic adolescents aged 13-16, utilizing the EV3 programming application on tablets to transform traditional building blocks into programmable dynamic collaboration.Arshad[14] successfully assembled the EV3 into a 22.5 cm tall and 17.5 cm wide PvBOT educational robot for teaching mathematics to eight children with autism, which significantly improved their cognitive test scores (p=0.00013).

For the integrated education of upper primary and secondary school students, the social needs of children with autism have evolved from basic interaction to complex collaboration, while also requiring academic integration. Lego robots combine social intervention with subjects such as programming and mathematics, achieving dual integration of social skills and academic abilities, while simultaneously enhancing the intervention motivation of older children with autism.

（3）As a benchmark for high-tech mixed reality (MR) evaluation

Currently, the standard Lego tool has become a benchmark for testing cutting-edge intervention technologies due to its effectiveness. In a series of studies by Crowell et al. [16][17] (2019,2022) evaluating the full-body interactive mixed reality system "Lands of Fog", traditional Lego was set as the non-digital control group. Robotics has evolved into two completely different tool forms in Lego therapy. Raghavendra [15], targeting teenagers aged 13-16, upgraded the tool to an EV3 Lego robot integrated with a tablet application, significantly improving attendance and motivation among older autistic individuals. Arshad[15] similarly employed EV3 to assemble a 22.5 cm-tall 'PvBOT' robot, equipped with a movable mat and digital placeholder cards, which enabled the intervention group to achieve a mathematics cognition score of 91.25.Narzisi's systematic review identified Huskens' groundbreaking experiment, which directly employed humanoid robots to replace human therapists or instructors.[12]

（4）Objective Evolution of Physiological Monitoring Tools

The evaluation tools for Lego intervention are also breaking through the subjectivity of traditional "behavior observation scales" and evolving towards objective physiological indicators. Sayis [12] introduced wearable devices during the Lego intervention process, equipping children with "kid-friendly wearable" designed by FuBIntLab. The tool objectively records the physiological arousal and actual anxiety levels of children in Lego social interactions second by second through skin electrical activity and electrocardiogram sensors, thereby achieving physiological precision in the evaluation of intervention effects.

In inclusive education, the intervention assessment for children with autism spectrum disorder (ASD) is often influenced by teachers' subjective judgments. Objective physiological monitoring tools enhance the accuracy of assessments and provide data support for personalized adjustments of LEGO therapy in inclusive education.

（5）Other strategies

Other supporting strategies include visual environment support, behavioral reward system and adult facilitative withdrawal. In terms of visual and environmental support, the study extensively utilized role name

badges, visualized rule posters, and dialogue initiation cards [9][11][15].To meet specific experimental requirements, traditional square tables have been innovatively modified. For example, the research by Crowell [12][16][17] and others specifically designed the "Hexagonal LEGO Table" to meet children's physical movement needs in space. In terms of the behavior reward system, they established a token economy based on the "LEGO Club," naturally reinforcing positive teamwork behaviors by issuing LEGO point stickers or "Builder Certificates" upon completing models.[15],[18][9],[19]

IV. Discussion and Outlook

（1）Core mechanism of action: Physicalization and structural dimensionality reduction of abstract social rules

The profound mechanism behind the significant intervention effects of Lego therapy on children with autism lies in its successful "physicalization" and "structuralization" of abstract social rules. Traditional behavioral interventions often focus on top-down defect correction, whereas this therapy is based on the Systematic-Empathy (E-S) theory, aligning with the cognitive advantage of children with autism who prefer highly structured and predictable things. By utilizing the physical causal feedback of building block assembly, it significantly reduces their cognitive load when facing unknown social situations. More importantly, the precise role division of "engineer-supplier-architect" in the therapy constructs a mandatory natural social scaffold, transforming complex tasks such as shared attention, turn-taking, and verbal communication into essential requirements for completing collaborative construction tasks. This internalizes the intervention from externally imposed skill training into the children's intrinsic need for cooperation.

（2）Advantages of Inclusive Education: Niche Reshaping from "Clinical Isolation" to "Substantive Inclusion"

In the inclusive education ecosystem, the Lego therapy demonstrates unique advantages and high natural compatibility in transitioning from "clinical isolation" to "substantive integration." As a globally popular standard toy, the conventional attributes of Lego remove the stigmatizing label of special intervention, enabling typically developing children in regular classes to naturally integrate as peer models without barriers. This effectively promotes the transition of autistic children from physical coexistence to the construction of substantive social relationships. Additionally, addressing the pain points of intervention tools in middle and upper grades of inclusive education, such as their tendency to be too young and difficult to integrate into daily teaching, the Lego therapy provides an excellent solution for the evolution of EV3 robots and programming. It unprecedentedly deeply integrates social skills intervention with STEM (science, technology, engineering, mathematics) subject education, enabling autistic students to enhance their social collaboration skills while also maintaining academic performance in regular upper-grade courses, achieving a "double helix" integration of social development and academic improvement.

（3）Future Outlook: Adaptive Intervention Microecology Tending Towards Digitalization, Objectivity, and Intelligence

Looking ahead, with the continuous deepening of the integrated education system, the development of Lego therapy will inevitably break through the limitations of a single physical tool and advance toward the forefront of precise intervention characterized by digitization, objectivity, and intelligence. To address the current over-reliance on teachers 'subjective behavioral observations for intervention effectiveness, future intervention assessments should deeply integrate wearable physiological monitoring devices such as skin conductance and electrocardiograms to build a multimodal evaluation database of "subjective behavior-objective physiology." This not only helps accurately capture the latent stress and genuine emotional arousal of autistic children during interactions but also penetrates the "social masking" they are forced to display in regular classrooms. Meanwhile, combining mixed reality (MR) and artificial intelligence technologies, the future intervention ecosystem is expected to introduce AI agents as auxiliary facilitators, dynamically adjusting environmental support and intervention strategies based on children's real-time physiological feedback and task progress, ultimately forming a highly elastic, low-anxiety, and self-adaptive human-machine collaborative intervention micro-ecosystem.

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