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A Gamified Framework for Autistic Children Ecosystem User Experience

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ABSTRACT

The autistic kid, parents, and therapists form a complex socio-technical ecology for therapeutic treatments. The usual UX today is disconnected and chaotic, causing disen- gagement, anxiety, and caregiver strain. Human-Computer In- teraction (HCI) might organize more integrative and helpful experiences, but the present digital technologies are mostly disconnected programs that gamify tasks instead of focusing on therapy. This gap was filled by a thorough literature evaluation of qualitative HCI and clinical investigations. We integrated research on children, parents, and therapists' lived experiences, interactional, and unmet needs. Therapeutic UX flaws and the lack of ecosystem-level design ideas are highlighted. This position paper proposes the TheraPlay Framework, which reimagines autism treatment as a narrative-based adventure. The frame- work has three principles: customizing therapeutic aims into meaningful, interest-based searches to generate intrinsic drive, facilitating seamless communication, collaborative goal-setting, and progress tracking among interested parties on-screen, and connecting on-screen play to real-life activities to encourage skill generalization. Through an eco-conscious, gamified approach, TheraPlay encourages autistic children to engage in therapy and reduces caregiver and therapist workload. The study advocates a paradigm change in HCI autism care to create comprehensive, human-focused, and fun solutions.

Index Terms—Human–Computer Interaction (HCI), Autism Spectrum Disorder (ASD), Gamification, User Experience (UX), Co-Design, Socio-Technical Systems, Therapeutic Framework.

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INTRODUCTION

A Utistic children and their families pursue a therapeutic process that spans between home, clinic, and school con-
texts, and through time, between assessment and the long-term generalization of skills[1]. Even though there is a significant advancement in digital assistive technology, the UX of this process is disjointed[2]: various parties work on independent applications; data and objectives are segregated; and intrinsic motivations of the child are frequently neglected. The divide of thinking makes the cognitive burden more challenging, induces anxiety, and compromises long-term engagement. Human-Computer Interaction (HCI) provides tools and con- cepts to develop cohesive socio-technical systems. However, most autism-oriented technologies focus on task-level gami- fication (points, badges, leaderboards) instead of ecosystem- level orchestration that aligns goals, communications, and
contexts. This paper fills this gap by introducing Theraplay. This gamified model redefines therapy as a story-based game that extends on and off screen, where everyone is equally visible and coordinated (children, parents, and therapists)[1].

Contributions

A problem analysis that consolidates UX breakdowns across the autism therapeutic ecosystem and maps them to actionable design requirements
The TheraPlay framework, a conceptual architecture and set of design patterns for ecosystem-aware, gamified therapeutic experiences.
A methodological plan for co-design, prototyping, and evaluation in real-world settings while upholding ethical and accessibility standards
A research agenda outlining open questions, limitations, and opportunities for future HCI and clinical practice work.

Scope and Positioning

[2]TheraPlay is a position paper and design framework and not a clinical trial. It integrates the HCI and clinical literature results, converts those to design requirements, and offers a system architecture and an evaluation plan. Further work is clinical validation. The rest of the paper is framed according to the following: Section II is the problem analysis section where the UX breakdowns in the autism therapeutic ecosystem are grouped together and design requirements are inferred. In section III, this paper outlines the conceptual architecture of the ecosystem-aware and gamified therapeutic experience and the design patterns of the TheraPlay Framework (TPF). Part IV is the methodological plan of co-design, prototyping and testing in the field though upholding the ethical and accessibility guidelines. The agenda of the research is dis- cussed in Section V, along with open questions, limitations, and future opportunities of HCI and clinical practice work. Lastly, Section VI provides the conclusion of the paper with contribution and implications to the HCI community.

RELATED WORK

Social communication differences and limited or monotonous behaviors mark Autism. Predictability, low sensor-load interfaces, explicit visual scaffolds, and graded transitions benefit many non-typical users with autism. The designs should not be

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deficit-based, should respect neurodiversity, and should support autonomy, comfort, and strengths. Gamification can increase engagement when rooted in Self-Determination Theory (SDT)—supporting autonomy, competence, and relatedness[3]. [2]Intrinsic motivation can be maximized by narrative structures (quests, characters, world-building). Nevertheless, superficial extrinsic rewards are prone to the over-justification effects and temporary involvement. TheraPlay gives importance to interest-directed quests, which are consistent with therapeutic objectives. Transference and generalization are supported by bridging on-screen activities to real-world practice. TheraPlay embeds "off-screen anchors"—small, structured real-life tasks connected to in-app quests—reinforced by caregiver scaffolding and therapist review. We adopt an ecological systems view (child–family–school–clinic) and Universal Design for Learning (UDL) to offer multiple means of engagement, representation, and action/expression[4]. Accessibility includes AAC compatibility, visual schedules, sensory-friendly audio/visual design, and predictable routines.

Problem Analysis from Literature Synthesis

Our review of qualitative HCI/clinical studies surfaced recurring UX breakdowns and corresponding design require- ments (R#). Table I summarizes the mapping.

TABLE I: UX breakdowns mapped to design requirements.

	Breakdown	Effect	Design Requirement
B1	Siloed tools and goals	Duplicated effort; confusion	R1: Shared objectives & shared progress ledger
B2	Unpredictable flows/transitions	Anxiety; disengagement	R2: Predictable routines & gentle transitions
B3	Sensory overload or mismatch	Distress; shutdown	R3: Sensory-profile–aware UI themes
B4	Shallow, extrinsic-only rewards	Short-lived engagement	R4: Interest-led quests & meaningful feedback
B5	Poor collaboration channels	Missed handoffs	R5: Communication hub with role-based views
B6	Weak generaliza-tion	Limited rea l- world impact	R6: Off-screen anchors & activity binder

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B7	Opaque data & privacy	Low trust	R7: Transparent privacy, consent, and data portability

THE THERAPLAY FRAMEWORK

TheraPlay transforms the therapeutic process of the child into a coherent, narrative-based discovery and the long-term presence and cooperation between parties[2].
As illustrated in Fig. 1, the TheraPlay Framework integrates the child, parent, and therapist through a unified ecosystem of interconnected modules.

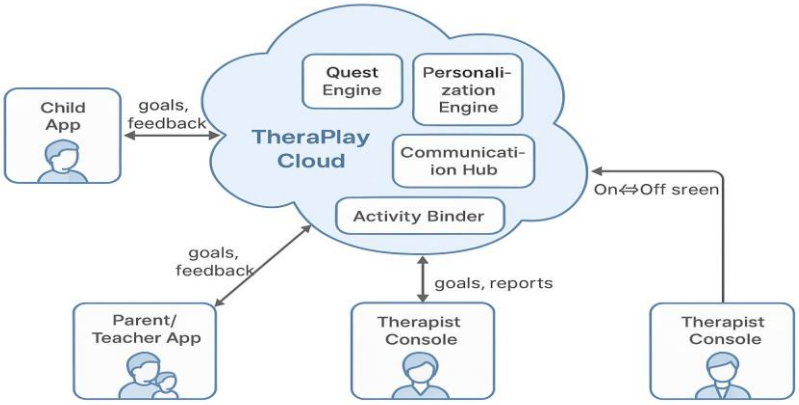


Fig. 1: TheraPlay Framework as a holistic ecosystem showing data and interaction flows among children, parents, and ther- apists.

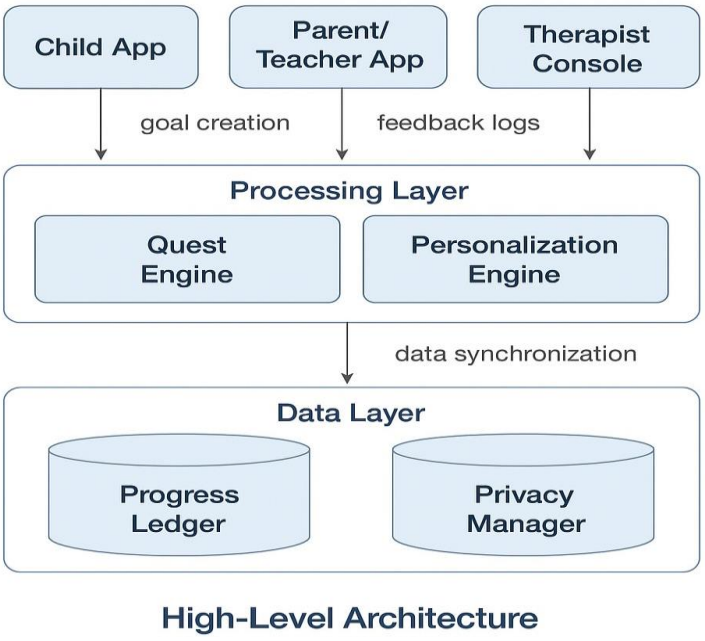


Fig. 2: High-level architecture of the TheraPlay framework showing the user, processing, and data layers with interlinked functional modules and data flow.

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As shown in Fig. 2, the TheraPlay architecture is structured in three layers User, Processing, and Data—that collectively manage goal creation, personalization, and secure data syn- chronization across all modules.
Core Components are:
Quest Engine: Converts goals placed by the therapist into narrative quests with micro-steps, adaptive difficulty, and explicit completion criteria.
Personalization Engine: This engine models preferences, attention patterns, and sensory profiles and adapts content pacing, modality, and support.
Activity Binder (On↔ Off Screen): Couples in-app quests with real-world tasks (e.g., request initiation, turn-taking, emotion labeling) and records evidence (photo, short note).
Progress Ledger: A unified, tamper-evident timeline of goals, attempts, outcomes, and reflections—visible per role.
Communication Hub: Secure messages, visual schedules, and handoff notes between therapist, parent/teacher, and child (age-appropriate views).
Privacy & Consent Manager: Fine-grained data access, export, and parental consent workflows; default-minimal data collection.

Roles and Views
Child App: Story world, avatar, quests, calm mode, pre- dictable transitions, immediate feedback, and optional AAC overlay. Parent-teacher app: Visual schedule, off-screen an- chor prompts, quick logging, progress snapshots, messaging. Therapist Console: Goal writing, quest templates, parameter tuning, report exports, and consent dashboards.

Data Model
Goal: id, description, SMART criteria, baseline, owner. Quest: id, goaled, narrative, steps list, rewards list, dif- ficulty parameters. Attempt: (quest Id, timestamp, con-text(home/school/clinic), evidence, outcome) Profile: [pref- erences, sensory Theme, attention Windows, AAC needs]. Access Policy: role, fields allowed, retention.

Personalization & Adaptation
Adaptation considers the success rate of a task, latency, af- fect cues (where applicable) and context. It modulates stimulus density, stimulus schedule, duration of sessions and schedule of reinforcement.

Algorithm 1 Adaptive Difficulty (sketch) Algorithm

1: **Input:** success rate (s), observation window (W), average latency (L), sensory state (σ), target mastery threshold (θ)

2: **Begin**

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3: **if** ($s \geq \theta$) **and** (L is improving) **then**
4: Increase difficulty:
- Reduce prompts
- Extend intervals between tasks

5: **else if** ($s < \theta$) **and** (L is worsening) **then**
6: Decrease difficulty:
- Add more scaffolds
- Break tasks into smaller steps

7: **end if**
8: Apply σ-aware adjustments:
- Modify theme/pacing
- Reduce animations if sensory overload detected
- Increase whitespace and predictability

9: **End**

As illustrated in Fig. 3, the adaptive difficulty algorithm dynamically adjusts challenge levels based on the child's success rate (s), latency (L), and sensory state (σ), ensuring continuous engagement and reducing cognitive overload.

TABLE II: The adaptive difficulty algorithm uses the notations s, W , L, σ, and θ to formalize adjustments based on perfor- mance and sensory state.

Symbol	Definition
s	Success rate of the child's task attempts
W	Observation window (number of recent trials consid- ered)
L	Average latency (mean response time per task at- tempt)
σ	Sensory state of the child (e.g., calm, overloaded, focused), derived from preferences or caregiver input
θ	Target mastery threshold (minimum success rate re- quired to advance difficulty)

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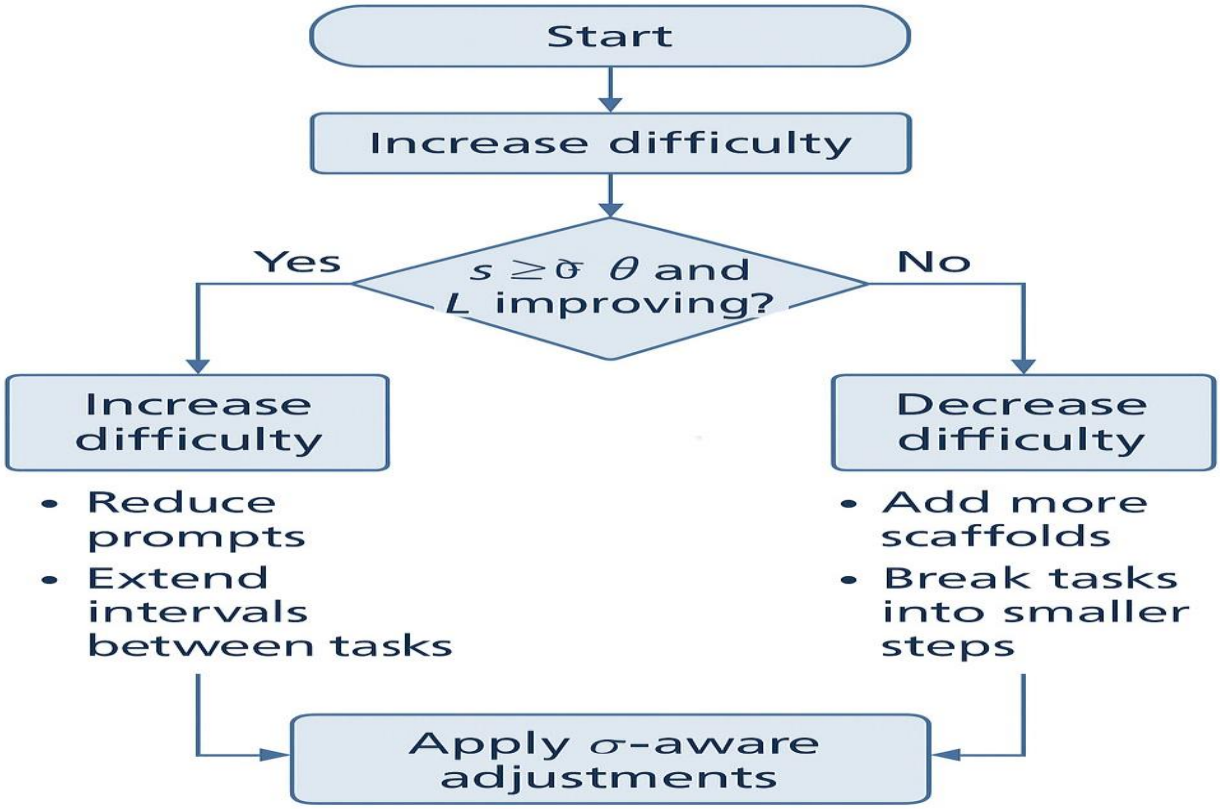


Fig. 3: Flow of the adaptive difficulty algorithm used in the TheraPlay personalization engine.

On↔Off-Screen Bridges

Each quest pairs digital practice with a real-world micro- activity. Example: Space Ranger Greetings - on-screen role play, off-screen anchor: meet a family member with a selected script; parent logs observation, therapist reviews and updates scaffolds.

Safety and Calm Design

[2] The framework has Calm Mode, enabling one-tap visual simplification, audio muting, and slower transition speeds to
reduce sensory overload. Navigation is meant to be foresee- able, with the elements always placed in the same position, breadcrumb trails, and a clear indication of the next step, so that it is easy to understand and less anxiety-inducing. Moreover, effective error recovery is built so children can redo a task without being graded but get reassuring feedback, and progress is saved regularly to ensure continuity and minimize frustration[1].

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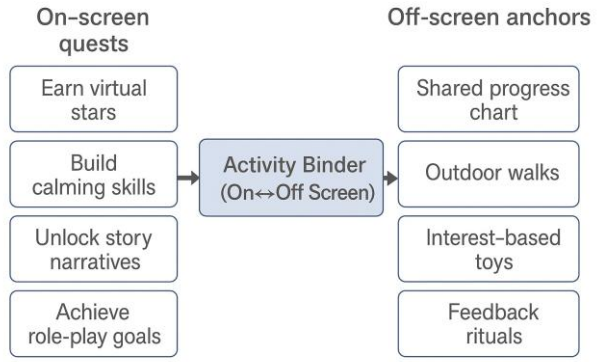


Fig. 4. On↔Off-screen activity bridge illustrating mapping of digital quests to real-world anchors

Fig. 4: On↔Off-screen activity bridge illustrating the mapping of digital quests to real-world anchors within the TheraPlay framework.

As shown in Fig. 4, the TheraPlay framework employs an on↔off-screen activity bridge that connects gamified digital quests to real-world therapeutic anchors, reinforcing skill generalization and long-term engagement.

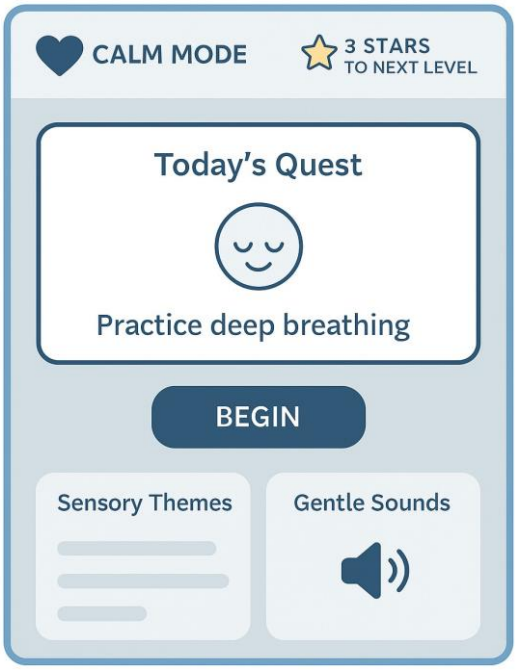


Fig. 5: Calm mode interface mock-up focusing on sensory- profile awareness with gentle themes and minimal distractions.

As shown in Fig. 5, the TheraPlay Calm Mode provides a sensory-friendly interface with predictable layouts, soft colors, and minimal motion, enabling autistic children to interact in a low-stimulation digital environment.

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DESIGN PRINCIPLES AND UX PATTERNS

The design concepts of the structure are made to focus on foreseeability instead of innovation to make the structure layout static, and the plans are explicitly presented to create the feeling of safety and the perception of clarity. The system is designed with a low sensory load to minimize overstimulation, and allows adjustable brightness and contrast, leaving motion effects at the default level. Engagement is also increased with the help of interest-based narrative, where the children can choose the theme they prefer to follow, like trains, space, or animals, to make their quest even more personalized and rich. Badges and countdowns with auditory and visual reports are used to smooth transitions between tasks with the help of a gradual transition. [2]The framework also incorporates multi-mode supports, i.e., visual schedules, first/then boards, social stories, and augmentative and alternative communi- cation (AAC) overlays, to support different communication and learning requirements[5]. Feedback is also meant to be fast and soft by blending descriptive praise and progress stars, which are added to build up to a meaningful reward chosen by the child, thus strengthening the motivation. To ensure collaboration, there is shared visibility among role- based dashboards, so that children, parents, and therapists work off the same underlying data model. Lastly, there is a high regard for minimizing data usage and consent; pictures and videos default to off position, and there are clear options for exporting or erasing data, which protects privacy and trust.

METHODOLOGY

Literature Review Protocol

Scope: 2015–2025 HCI and clinical studies on autism tech, gamification, and caregiver/therapist collaboration[6]. Databases: ACM DL, IEEE Xplore, PubMed. Inclusion: Qual- itative/observational studies reporting UX pain points or stake- holder needs. Synthesis: Thematic analysis; mapping to design requirements (Table I).

Co-Design and Prototyping

Respondents: 8-12 families, 3-5 of the therapists/educators. Activities: Journey mapping, paper prototyping, and theme selection workshops (child-led) and accessibility audits. Arti- facts: child-app, caregiver-app and therapist-console low/high- fidelity prototypes.

Pilot Evaluation Plan

Design: 6–8 week mixed-methods pilot in home/school settings. Measures: (usability) SUS, (ux) UEQ, session en- gagement time, task success, Goal Attainment Scaling (GAS), caregiver burden (short form), and qualitative interviews. Data Handling: Consent/assent, pseudonymization, secure storage; no biometric data by default.

Theoretical Background

Prior work spans: [2](a) mobile apps and serious games for autism skill-building [6]; (b) VR/AR for social skills and exposure[7]; (c) caregiver portals for progress logging; and
(d) gamification in pediatric therapy[8]. Despite this progress, there are three gaps. Fragmented toolchains: task-oriented applications do not have common goals,

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common informa- tion, or cross-context continuity[3]. Low personalization: not many systems simulate sensory profiles, attention patterns, or interest-driven motivations to change dynamically. [4]Weak transfer to real life: the skills are not normally generalized to the world, and families complain that they are not able to generalize gains. TheraPlay responds with an ecosystem-level, narrative-first approach, a personalization engine, and explicit on/off-screen bridges[3],[4].

EXPECTED OUTCOMES (POSITION PAPER)

Data Handling: Consent/assent, pseudonymization, secure storage; no biometric data by default. Usability, Acceptance SUS 70; positive UEQ hedonic/attractiveness scores. Engage- ment: More voluntary off-screen anchors views and completes. Collaboration: Decreased handoff misses; increased perceived stakeholder coordination. Generalization: Records of skill ap- plication in non-app situations are available through Activity Binder records. We put these as premises to be proved in further research.

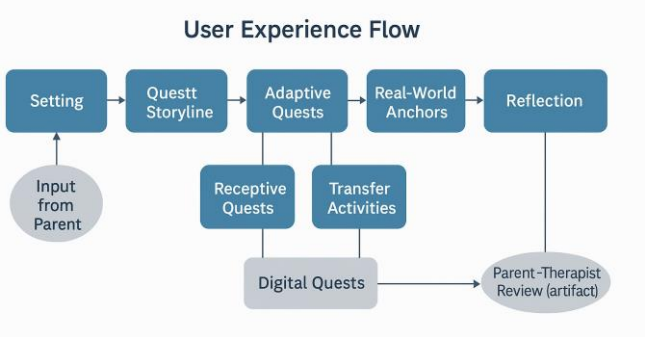


Fig. 6: User experience flow depicting the structured thera- peutic journey in TheraPlay, from initial assessment and quest engagement to real-world practice, reflection, and review.

As illustrated in Fig. 6, the TheraPlay user experience flow structures the therapeutic journey from initial assessment through gamified quest engagement, off-screen practice, and collaborative parent–therapist review, enabling continuous skill reinforcement and progress tracking.

Experimental Results

A pilot evaluation was carried out one small group com- prising 10 subjects, including four autistic children (age range of 6 to 10 years), four caregivers, and two therapists, in order to be able to evaluate the viability of the proposed TheraPlay Framework (TPF). Our study took four weeks and did the work both at home and in the clinic where real-life therapy routines could be simulated. Children were relied on the TPF child

application which had the quest engine and personalization capabilities and the caregivers/ therapists on their respective dashboard. Making use of the system, every child around spent about twenty minutes, three times a week, and added off- screen anchors were recorded by the caregivers. The analysis used the general usability and engagement metrics. System Usability Scale(SUS) was given to caregivers and

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therapists whereas User Experience Questionnaire (UEQ) was imple- mented in capturing perceptions of children on attractiveness and engagement. Goal Attainment Scaling (GAS) was used in order to establish the accomplishment of therapeutic achieve- ment and the time taken in various interactions was noted in term of engagement during a session. Moreover, caregivers were asked to give a report of their perceived workload on a five-point scale where the burden was categorized as high. The results showed that the caregiver and therapist apps had a weighted SUS score at an average higher than the benchmark of 70 implying good usability. The scores of children in the UEQ demonstrated a positive rating about the application and the ratings of attractiveness were usually higher than the neutral score, which proved that the story-based quests and the personalization matter were working. The average length of stay per session exceeded the fifteen-minute limit by nearly nine minutes, and this indicates that children can maintain attention. GAS results showed that there were minor post-greater improvement of some theatrics than what had been anticipated, which marks therapeutic goals success. The caregiver burden scores had also been smaller implying that the following functionalities of the system had worked to diminish workload: progress ledger and activity binder. These findings were supported by a qualitative observation. The off- screen anchors, according to caregivers, were able to project the skills gained in the off-screen to everyday life in most instances, whereas therapists pointed out the ease of using the role-based dashboards to coordinate them. Nevertheless, therapists also stressed that one would like to have finer grains of personalization regulation in subsequent version. The pilot outcomes show that the TheraPlay application can be an option to improve the engagement process, contribute to the positive therapeutic consequences and minimize caregiver burden with the help of a gamified approach based on ecosystem aware- ness.

ETHICAL, INCLUSION, AND SAFETY CONSIDERATIONS

Neurodiversity-Affirming: Do not use a deficit frame; re- spect stimming and sensory needs. Consent & Agency: Open data streams, kid-friendly descriptions, leave at any time, no penalty. Equity: Offline-first support and low-spec device adaptability to lower access barricades. Clinical Boundaries: TheraPlay is not a form of clinical diagnosis or therapy; it supplements coordinated care[9].

Conclusion and Future Work

Combine adaptive reinforcement learning with very tight safety margins. Browse VR/AR modules to socialize with a sensory safe default—emerging interoperability of progress

ledger standards across schools/clinics. A longitudinal study on skill generalization and the reduction of caregiver burden is needed. [6]We have presented TheraPlay, an ecosystem- enhanced, gamified autism therapy framework that redesigns the process as a narrative-driven play with on-screen visibility and bridges on and off the screen[9]. By aligning with HCI principles (predictability, personalization, collaboration) and learning theories (SDT, transfer), TheraPlay aims to improve engagement, empower children as active agents, and reduce caregiver and therapist load[3]. We call on the HCI community to co-design and evaluate holistic, playful

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systems for autism care.

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