

USER-CENTRED DESIGN OF THERAPEUTIC DEVICES FOR MOUNTED EQUINE-ASSISTED THERAPY WITH CHILDREN WITH INTELLECTUAL AND MOTOR DISABILITIES

Juan Carlos MARQUEZ CAÑIZARES, Diana Laura PÉREZ-DE LA ROCHA and Griselda Esthela OYERVIDES-RAMIREZ
Tecnológico de Monterrey, Mexico

ABSTRACT

Equine-assisted therapy (EAT) offers significant physical, cognitive, and emotional benefits for children with intellectual disabilities who also experience motor challenges. However, many therapeutic centres lack specialised devices that enhance intervention quality once the child is mounted on the horse, where posture control, engagement, and coordinated movement become critical. This study reports on a semester-long design project in which product design students developed two therapeutic devices to support mounted activities at FICAE Foundation in Monterrey, Mexico. The investigation followed a user-centred design approach. Students conducted targeted research on intellectual disability and motor impairment, combined with interviews and field observations during EAT sessions. These insights highlighted key therapeutic challenges: maintaining trunk stability, promoting bilateral coordination, and sustaining attention during mounted exercises. Based on this understanding, students generated initial sketches and low-fidelity prototypes, which were iteratively tested and refined through feedback from therapeutic specialists. Through cycles of making, testing, and redesign, both teams progressed toward high-fidelity functional prototypes tailored to the dynamic and safety-critical context of EAT. The resulting devices supported activities aimed at improving balance, posture, motor planning, and engagement, while also reducing therapist workload during mounted exercises. This project demonstrates the potential of integrating real-world therapeutic contexts into product design education, fostering student competencies in participatory design, prototyping, and evidence-based decision-making. It also contributes a replicable approach for designing context-specific therapeutic devices that address the needs of children with intellectual and motor disabilities participating in equine-assisted therapy.

Keywords: Equine-assisted therapy, disability, user-centred design, higher education, educative innovation

1 INTRODUCTION

Equine-assisted therapy (EAT), also referred to as therapeutic horseback riding or hippotherapy, has been recognised as a complementary intervention for children with intellectual disabilities and motor impairments. The three-dimensional and rhythmic movement of the horse resembles human gait, promoting postural adjustments that stimulate trunk control, pelvic mobility, balance, and neuromotor coordination [1], [2].

Trunk control is fundamental for functional motor development, directly influencing upper-limb coordination, head stability, and bilateral motor planning [3]. Previous studies have documented improvements in trunk stability, postural symmetry, and muscle activation after equine-assisted interventions in children with neuromotor disorders [1], [2]. Beyond motor outcomes, EAT has also demonstrated psychosocial and cognitive benefits, particularly in children with autism spectrum disorder (ASD) and intellectual disabilities. Reported outcomes include improvements in social communication, adaptive behaviour, attention, and emotional regulation [4–6]. The sensory inputs generated during mounted activities—particularly vestibular, proprioceptive, and tactile stimulation—may additionally support sensory integration and self-regulation processes [7–9]. However, the effectiveness of such stimulation depends on carefully structured interventions.

Despite the therapeutic benefits of EAT, innovation in this field has primarily focused on mounting systems, saddles, and protective equipment, while comparatively less attention has been given to therapeutic devices used once the child is already mounted. In practice, therapists frequently rely on improvised tools to stimulate reaching, trunk activation, and engagement, but these are rarely developed through systematic ergonomic or user-centred approaches. User-Centred Design (UCD) offers a relevant framework for addressing this gap by emphasising iterative development grounded in stakeholder needs, real contexts, and continuous evaluation [10], [11]. In healthcare and assistive product development, participatory and co-creative approaches have demonstrated improvements in usability, safety, and adoption [12], while inclusive design principles advocate for solutions responsive to functional diversity [13].

Within higher education, embedding authentic healthcare challenges into product design education can strengthen empathy, systems thinking, and socially responsible innovation [14]. Design-Based Research (DBR) and Research-through-Design (RtD) provide complementary methodological approaches for developing and evaluating solutions in real-world contexts while generating transferable design knowledge [15], [16].

In response to the lack of mounted therapeutic devices designed specifically for equine-assisted interventions, this study reports a semester-long user-centred design project conducted in collaboration with FICAE Foundation in Monterrey, Mexico. Product design students developed two mounted therapeutic devices—Towi and Spike—to support trunk stability, bilateral coordination, and cognitive engagement during therapy sessions.

This paper contributes by documenting the integration of UCD, DBR, and RtD methodologies in the development of mounted therapeutic devices for children with intellectual and motor disabilities, while proposing a replicable educational model for socially engaged product design practice.

2 METHODOLOGIES

2.1 Research Design Framework

This study adopted an integrated methodological framework combining Design-Based Research (DBR), User-Centred Design (UCD), and Research-through-Design (RtD). This triangulated approach allowed the project to operate simultaneously as a pedagogical intervention and as applied design research within a real therapeutic context.

Design-Based Research is characterised by iterative cycles of analysis, design, implementation, and refinement conducted in authentic environments [17]. Rather than isolating variables under laboratory conditions, DBR seeks ecological validity while generating transferable design principles [18]. Given that equine-assisted therapy occurs in dynamic, safety-critical conditions, DBR was particularly appropriate for structuring the development of mounted therapeutic devices.

User-Centred Design principles ensured systematic stakeholder involvement throughout the process. According to ISO 9241-210, UCD requires explicit understanding of users, tasks, and environments, iterative prototyping, and evaluation against user requirements [10]. Norman emphasises that usability and contextual fit emerge through continuous feedback and iteration rather than linear development processes [11]. These principles guided all design decisions.

Additionally, the study aligns with Research-through-Design approaches, in which knowledge is generated through the creation and critical reflection on artefacts [16]. In this project, the prototypes (Towi and Spike) functioned as epistemic artefacts that revealed insights about mounted therapeutic interaction, trunk engagement dynamics, and cognitive-motor integration.

2.2 Contextual Inquiry and Stakeholder Engagement

The research began with a contextual inquiry phase conducted at FICAE Foundation. Following participatory design principles [12], therapists were actively involved as expert stakeholders throughout the process. Data collection methods included: (1) non-participant observation of mounted therapy sessions, (2) Semi-structured interviews with therapists [19], (3) Task decomposition analysis of mounted exercises and (4) Documentation of existing improvised therapeutic tools

Observation focused particularly on trunk alignment instability, bilateral reaching limitations, attention fluctuation, and therapist physical workload. These aspects are consistent with the importance of trunk stability in motor development [3] and documented therapeutic goals in hippotherapy research [2]. Children were not directly involved in co-design workshops due to ethical and safety considerations.

However, behavioural responses during sessions informed design refinements indirectly through therapist feedback.

2.3 Problem Framing and Requirement Definition

Field data were synthesised into structured design requirements during a formal problem-framing phase. Following DBR guidelines [17], the initial qualitative findings were translated into operational criteria: (1) Adjustable saddle integration, (2) non-rigid structural surfaces, (3) Lightweight configuration, (4) Quick-release safety mechanisms, (5) Modular adaptability (6) Easy sanitation.

Safety constraints were prioritised due to the unpredictable dynamics of equine movement. As documented in therapeutic riding literature, trunk instability and fatigue can alter postural alignment rapidly [2], requiring devices that support without rigid immobilisation.

2.4 Iterative Prototyping Cycles

The development phase consisted of four iterative cycles structured according to DBR principles [18] (see Table 1), and each cycle incorporated structured feedback loops consistent with iterative UCD practice [10] and co-creation models [12],[20].

Table 1. Cycles of prototyping

Cycle	Description
1 – Concept Exploration	Sketch development and low-fidelity cardboard modelling to explore reach zones and saddle compatibility.
2 – Low-Fidelity Testing	Foam prototypes tested in simulated mounted positions to assess: (1) Balance interference, (2) Ergonomic reach, and (3) Therapist accessibility
3 – Mid-Fidelity Functional Prototypes	Introduction of EVA foams, reinforced textiles, and modular connectors. Therapists evaluated usability and therapeutic applicability during controlled mounted simulations.
4 – High-Fidelity Refinement	Structural optimisation of attachment systems, weight distribution, and edge geometry. Final prototypes were evaluated for: (1) Safety compliance, (2) Installation time, (3) Cleaning feasibility, and (4) Therapeutic task integration

2.5 Evaluation Strategy

The evaluation approach was qualitative but systematically structured. Criteria were organised into five categories as you can see in Table 2:

Table 2. Evaluation Criteria

Category	Evaluation Focus
Safety	Secure fixation, absence of rigid protrusions, rapid detachment
Ergonomics	Reach range compatibility, trunk alignment facilitation
Therapeutic Function	Promotion of bilateral coordination and active postural correction
Usability	Installation time, therapist handling effort
Engagement	Sustained attention and task participation

Although quantitative biomechanical measurements were beyond the scope of this academic studio, therapist assessments provided practice-based validation aligned with rehabilitation research models [3].

2.6 Knowledge Generation Through Design

Consistent with Research-through-Design methodology [16], knowledge emerged through reflective analysis of iterative artefact development. Three preliminary design principles were identified: (1) Controlled instability enhances trunk activation, rather than rigid stabilisation. (2) Modular tactile interaction improves mounted attention span, particularly in children with sensory processing variability. (3) Embedded task-structure reduces therapist improvisational workload, increasing session consistency. These findings contribute initial transferable guidelines for the design of mounted therapeutic devices in equine-assisted contexts.

3 RESULTS

The design process resulted in two fully functional high-fidelity prototypes: Towi and Spike. Although both devices emerged from the same methodological framework, they addressed distinct therapeutic dimensions within mounted equine-assisted therapy: postural-motor stabilisation and cognitive-motor engagement. In Table 3, you can see a comparison between both projects with nine Dimensions.

Table 3. Comparative evaluation of mounted therapeutic devices

Evaluation Dimension	Towi	Spike
Therapeutic Objective	Enhancement of trunk stability and bilateral motor activation	Enhancement of cognitive-motor engagement and attention structuring
Targeted Functional Deficit	Postural instability and limited midline crossing	Attention fluctuation and difficulties in task sequencing
Interaction Mechanism	Controlled lateral instability requiring continuous postural adjustment	Embedded modular tasks combining tactile and visual stimuli
Postural Activation	Direct facilitation of upright alignment and trunk engagement	Indirect activation through task-oriented movement
Bilateral Coordination	Promotes symmetrical reaching and midline crossing	Promotes alternating-hand interaction and motor planning
Attention and Engagement	Moderate increase through motor activation	High increase through structured task sequencing
Therapist Interaction Demand	Reduces need for manual trunk stabilisation	Reduces need for task improvisation and guidance
Adaptability and Modularity	Adjustable level of instability and support	Reconfigurable task modules with progressive complexity
Design Strategy (RtD Insight)	Dynamic stabilisation through controlled instability	Cognitive structuring through embedded task architecture

The comparison presented in Table 3 is structured based on the evaluation criteria defined during the design process (Table 2), expanded to include interaction mechanisms and design insights derived through Research-through-Design. This allows for a systematic comparison of both therapeutic performance and design contribution.

In the case of Towi, although no quantitative biomechanical measurement tools were used, structured therapist feedback identified: (1) Faster task initiation, (2) Improved bilateral coordination during object transfer, and (3) More consistent postural alignment across session duration. Importantly, no interference with reins, therapist positioning, or horse movement was observed.

In the case of Spike, therapists reported that alternating-hand task sequences improved bilateral coordination and motor planning. This supports sensory integration frameworks suggesting that structured proprioceptive and tactile input can reinforce motor planning processes [8], [9]. Importantly, the modular reconfiguration capability allowed progressive task complexity without changing the base device. While both devices improved mounted task structure, their primary contributions differed:

- Towi enhanced postural activation and trunk engagement.
- Spike enhanced attention regulation and cognitive sequencing within motor tasks.

Towi's impact was primarily biomechanical, addressing trunk alignment and midline crossing. Spike's impact was primarily cognitive-sensory, structuring task engagement and attention span. Together, they illustrate complementary design strategies within the same therapeutic ecosystem.

4 DISCUSSION

The results suggest that mounted therapeutic devices developed through an integrated human-centred and design-based framework can enhance equine-assisted therapy without disrupting its underlying biomechanical principles [1], [2].

Towi primarily amplified postural-motor engagement. By introducing controlled instability rather than rigid stabilisation, it promoted active trunk correction, aligning with evidence that trunk improvements in hippotherapy emerge from dynamic neuromotor activation [1], [2]. Given the foundational role of trunk control in coordinated motor function [3], the observed improvements in midline crossing and

bilateral activation indicate that context-sensitive design can extend established therapeutic mechanisms. Spike, in contrast, enhanced cognitive-motor engagement. Increased attention and task consistency align with findings that equine-assisted interventions support behavioural regulation in children with ASD [4–6]. However, this study suggests that embedding task structure directly into the artefact can intensify these effects. The modular tactile configuration reflects sensory integration principles, where structured multisensory input supports motor planning and self-regulation [7–9].

Together, both devices illustrate complementary strategies: biomechanical amplification through controlled instability (Towi) and cognitive structuring through embedded task architecture (Spike). From a design perspective, three implications emerge. First, therapeutic stabilisation should prioritise dynamic engagement over immobilisation. Second, embedding task logic into artefacts enhances repeatability and reduces therapist workload, consistent with user-centred design principles [10], [11]. Third, modularity enables adaptability to functional diversity, aligning with inclusive design approaches [13].

Methodologically, the integration of Design-Based Research and User-Centred Design enabled iterative refinement within a real therapeutic context, ensuring ecological validity [17], [18] and stakeholder alignment [12]. Through Research-through-Design, the prototypes functioned as knowledge-generating artefacts, extending their contribution beyond functional performance [16].

Overall, this study positions product design as an active mediator within therapeutic ecosystems. By integrating biomechanical and cognitive dimensions into mounted artefacts, design can amplify both motor and engagement outcomes in equine-assisted therapy.

5 CONCLUSIONS

This study explored the development of mounted therapeutic devices within equine-assisted therapy through an integrated framework combining Human-Centred Design, Design-Based Research, and Research-through-Design. Conducted in collaboration with a therapeutic foundation, the project resulted in two functional prototypes—Towi and Spike—addressing complementary therapeutic dimensions: trunk stability and cognitive-motor engagement.

The findings suggest that product design can meaningfully enhance therapeutic interaction without altering the fundamental biomechanical principles of equine-assisted therapy documented in prior research [1], [2]. Towi demonstrated that controlled instability can promote active trunk engagement rather than passive stabilisation, reinforcing the foundational role of postural control in coordinated motor performance [3]. Spike illustrated that embedding structured cognitive tasks into mounted artefacts can increase sustained attention and sequencing consistency, aligning with documented regulatory benefits of equine-assisted interventions in children with ASD [4–6].

Beyond device-specific outcomes, the study contributes three broader insights. First, therapeutic stabilisation strategies should prioritise dynamic activation over rigid immobilisation. Second, embedding task architecture directly into physical artefacts enhances repeatability and reduces therapist workload. Third, modular and adaptable systems are essential in addressing functional diversity in disability contexts.

Methodologically, the integration of Design-Based Research [17], [18] with User-Centred Design principles [10], [11] proved effective in maintaining ecological validity while generating transferable design knowledge. Through Research-through-Design [16], the prototypes functioned not only as solutions but as epistemic artefacts, revealing design principles applicable to broader therapeutic product development. Educationally, the project demonstrates the value of embedding authentic healthcare challenges within product design curricula. Students engaged with real safety constraints, interdisciplinary collaboration, and iterative refinement cycles, fostering socially responsible innovation grounded in contextual understanding.

While further quantitative validation is required to measure long-term clinical impact, the study positions design as an active mediator within therapeutic ecosystems. Mounted therapeutic devices, when developed through rigorous user-centred and iterative methodologies, can act as amplifiers of both motor and cognitive engagement in equine-assisted therapy.

ACKNOWLEDGEMENTS

The authors acknowledge the financial and technical support of the Writing Lab, Institute for the Future of Education, Tecnológico de Monterrey, in the production of this work, and the School of Architecture, Art, and Design Research Group - Advanced Design Processes for Sustainable Transformation - of

which they are members. Also, the support given by the FICAE Foundation and their personnel for the development of the projects.

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