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Children's study desk design that supports continuous learning through fun interactive design

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Abstract

The urgency of an adaptive learning environment is a decisive factor in fostering continuous education for early childhood, specifically those aged 5–6 years. Current observations reveal that conventional study desks in Kindergartens (TK) remain rigid, often failing to facilitate the vital synergy between structured learning and spontaneous play. This research, centered at TK Telkom Buah Batu Bandung, aims to develop an educational furniture piece that transcends basic ergonomics by integrating user-centered interaction design tailored to a child's developmental needs. The methodology adopts a comprehensive User Experience (UX) framework consisting of three pivotal phases: ethnographic observation of children's behavioral patterns, contextual interviews with educators to understand classroom dynamics, and rapid prototyping trials to gather immediate functional feedback. This UX data serves as the primary catalyst for an interaction design that harmonizes cognitive tasks with physical motor activities. The outcome of this study is a transformative modular desk capable of seamless transitions between a formal ergonomic learning mode and an interactive play configuration. Innovative features include explorative, erasable surfaces and integrated storage for educational tools, ensuring ease of access. Findings indicate that applying a UX-driven approach enhances student engagement, stimulates creative thinking, and facilitates fluid transitions between activities, thereby cultivating a joyful yet productive learning atmosphere. By synthesizing ergonomic requirements with the psychological nuances of the child's experience, this design establishes a new benchmark for creating effective, memorable, and interactive educational environments within TK Telkom Buah Batu.

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Keywords

Children's study table, Continuous learning, Enjoyable interaction design, User experience (UX), Early childhood education

Introduction

Current early childhood education often struggles to create a learning atmosphere that effectively integrates cognitive, motor, and affective growth. According to cognitive

development theories, children acquire knowledge through active engagement with their surroundings, particularly via play and direct exploration [1]. This aligns with the Montessori philosophy, which advocates for learning spaces that promote freedom of movement, autonomy, and sensorimotor experiences [2]. However, many kindergarten facilities still rely on traditional furniture that prioritizes academic functions over physical needs. These static and inflexible designs often ignore ergonomic standards and the behavioral nature of children, which may lead to discomfort, restricted exploration, and long-term postural issues [3], [4].

Existing literature has extensively documented how furniture ergonomics impacts a child's health and comfort. Anthropometric studies indicate that a mismatch between furniture dimensions and a child's body size can result in poor posture and musculoskeletal strain [3], [5]. Furthermore, researchers emphasize that design must account for the rapid physical growth and motor dynamics of young learners [6]. While interactive learning studies suggest that merging visual elements, physical activity, and play can boost focus and engagement [7], most research still treats furniture as a passive backdrop rather than a dynamic tool for learning.

A significant gap exists in the lack of integration between ergonomic health, interactivity, and adaptability within a single desk design. Most current products serve a single purpose and fail to transition smoothly between study and play. Additionally, the primary users the children themselves are rarely involved in the design process. Modern design theory, however, asserts that User Experience (UX) and active user participation are vital for creating meaningful and effective products [8].

To address these shortcomings, this study proposes a children's study desk concept rooted in User-Centered Design (UCD). This methodology places the child at the heart of the development process, resonating with interaction design theories that link the user, the product, and the context of use [8], [9]. The proposed design is both modular and multifunctional, capable of transforming from a traditional desk into an interactive play station. Key features include an erasable surface, accessible storage, and adjustable height settings. This approach aims to evolve furniture from a static object into an active educational medium that fosters creativity and sustained participation.

The primary goal of this research is to develop a kindergarten-level study desk that supports long-term learning through an engaging, ergonomic, and adaptive interface. Utilizing a UCD framework, the study encompasses a literature review, conceptual modeling, prototyping, and user-centric evaluations. The ultimate objective is to contribute to the field of educational furniture design by prioritizing a holistic learning experience over mere functionality.

Method

This research employs a product development framework rooted in User-Centered Design (UCD). This methodology prioritizes the user at every stage of the creative

process to ensure the final output aligns with their specific needs, capabilities, and lived experiences [10]. The selection of UCD is driven by the unique physical, behavioral, and psychological profiles of kindergarten students, who require an adaptive, experience-based design environment. The UCD phases implemented here involve analyzing the context of use, identifying user requirements, developing design solutions, and conducting direct usability testing [10], [11]. This logical sequence directly informs the subsequent presentation of results and discussions. The primary subjects include children aged 4 to 6 years, supported by kindergarten teachers as learning facilitators. Research was conducted within the natural setting of a classroom to capture authentic learning and play behaviors. Data was gathered through a multi-method approach: literature reviews, field observations, semi-structured interviews, and direct anthropometric measurements. The literature study establishes a theoretical foundation in furniture ergonomics, developmental psychology, and interactive play-based learning [1], [2], [5], [9]. Meanwhile, non-participatory observations focused on sitting postures and movement patterns during daily desk use. Interviews with educators further clarified classroom requirements and the limitations of existing conventional furniture. To ensure safety and comfort, direct anthropometric measurements were taken using portable tools. Key parameters included sitting height, elbow height, popliteal length, and reach distance. This data was cross-referenced with ergonomic standards to define precise desk dimensions, work surface areas, and legroom [3], [11]. These measurements ensure the furniture accommodates a child's natural posture during both academic tasks and physical play. The design phase translated user needs into manual sketches and digital models, focusing on a multifunctional desk that bridges the gap between study and play. Selection criteria prioritized ergonomics, safety, and functional flexibility. The chosen concept was realized as a 1:1 scale prototype utilizing multiplex for the work surface, supported by an aluminum and iron frame for structural durability and impact resistance in a high-activity environment. A novel aspect of this study is the application of modular rapid prototyping. This system allows for iterative design adjustments via a "knock-down" mechanism, eliminating the need for high-precision fabrication for every change. This method integrates UCD principles with modular systems, making the testing phase more efficient and flexible. The prototype underwent live testing where children engaged with it during classroom activities. Evaluation metrics included postural comfort, structural stability, and the ease with which children could transform the desk's functions or access storage. Qualitative feedback from teachers and descriptive ergonomic analysis of the children's interactions served as the final basis for refining the design into its definitive form.

Results and discussion

The outcome of this study is a functional prototype of a children's study desk equipped with a mechanical telescopic leg system. As shown in Figure 1, this innovative design allows the furniture to transition seamlessly between two primary configurations: "Play

Mode" and "Study Mode." Unlike traditional modular furniture, this functional shift is achieved solely through vertical height adjustments of the legs, eliminating the need for detaching or re-assembling additional parts. In the Play Mode configuration, the telescopic legs are set to their lowest position.

Figure 1. children's study desk equipped with a mechanical telescopic leg system.
Source: Personal Documentation

This adjustment causes the side panels to extend upward, forming a vertical safety perimeter around the work surface. These boundaries serve a practical purpose by preventing toys or learning materials from falling during constructive play, while simultaneously creating a more organized and psychologically secure zone for the child. Conversely, for Study Mode, the desk is elevated to a height that aligns with ergonomic standards. In this position, the previous perimeter walls align perfectly with the main surface to create a single, expansive flat plane. This orientation provides an optimal workspace for academic tasks such as drawing, writing, and reading. Remarkably, the transition between these two modes takes less than 10 seconds and can be performed easily by educators without the aid of specialized tools.

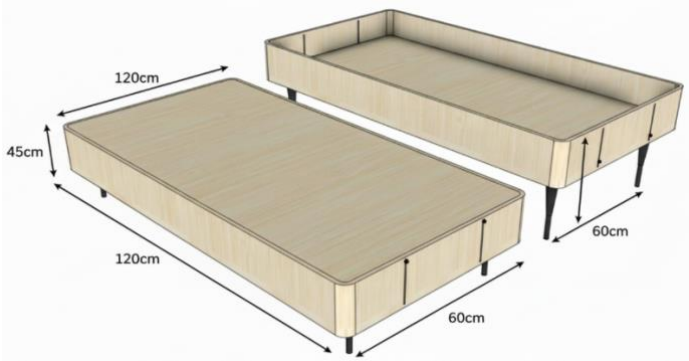

Figure 2. height range of children's study desks
Source: Personal Documentation

As shown in Figure 2, Ergonomic evaluations confirm that the adjustable height range of 45–60 cm adheres to the anthropometric data of children aged 4 to 6 years. Furthermore, structural stress tests demonstrate that the aluminum and iron framework can support static loads of up to 35 kg without showing signs of deformation or structural fatigue. Initial pilot testing with kindergarten students revealed a significant increase in focus duration during learning activities compared to conventional desks. Educators also reported that the swift transformation between play and study modes improved classroom management by maintaining a continuous

and uninterrupted instructional flow. The results of this study demonstrate that integrating a telescopic leg system provides an effective mechanical solution for balancing the two fundamental activities of early childhood: play and structured learning. This finding supports the theory of active exploration-based learning, which highlights the necessity of spatial flexibility for young learners [11]. In contrast to traditional static desks, this adaptive design allows the educational environment to pivot instantaneously alongside shifting classroom activities. The emergence of boundary walls during "Play Mode" serves a dual purpose. Beyond acting as a physical safety feature, these walls foster a focused psychological atmosphere for the child. This aligns with previous research suggesting that physical and visual boundaries can significantly boost concentration during constructive play sessions [12]. However, while prior studies often relied on manual "knock-down" or assembly systems, this design achieves full transformation through a single, unified movement mechanism. When transitioned to "Study Mode," the tabletop flattens, embodying the principles of dynamic ergonomics. This philosophy dictates that furniture must adapt to the user's physiology rather than forcing the user to compensate for the furniture's limitations [13]. The resulting height range satisfies established anthropometric standards for children, thereby potentially reducing muscle strain and the development of poor postural habits during academic tasks. Furthermore, the choice of aluminium and iron offers superior structural integrity and longevity compared to the standard engineered wood typically found in children's furniture. This reinforces earlier findings that lightweight metals are more effective for modular educational furniture subject to frequent reconfiguration [14]. From a usability perspective, observations indicated that children intuitively understood how to interact with the desk without needing complex guidance. This high level of affordance confirms that the design adheres to the core tenets of User-Cantered Design (UCD) within early childhood interaction theories [15]. Despite these positive outcomes, this study is limited by a lack of long-term longitudinal data regarding the mechanical durability of the telescopic joints under years of repetitive use. Future research should prioritize fatigue testing of the mechanical components and explore the integration of safer, automated locking systems. In summary, the telescopic leg system functions not merely as a height adjuster, but as a transformative element that successfully merges ergonomics, interactivity, and adaptability into a single educational tool.

Conclusion

This study confirms that a transformational study desk utilizing a telescopic leg system effectively addresses the dual requirements of early childhood education: a balance between play and academic learning. By integrating a singular, functional transformation mechanism, the research successfully achieves its goal of developing adaptive, ergonomic educational furniture that supports sustainable learning through engaging interaction design. A pivotal finding of this research is that a single mechanical system can serve a dual purpose regulating height while simultaneously reconfiguring

the child's activity space without increasing structural complexity. This approach reinforces the concept that educational furniture is not merely a physical utility but a medium of interaction that directly shapes a child's learning experience. These results resonate with the idea that spatial flexibility is vital for enhancing student engagement and the overall efficacy of early childhood pedagogy [16], [20]. The primary contribution to the field of educational product design lies in the simplification of furniture transformation systems, which have historically relied on cumbersome "knock-down" or manual assembly methods. Furthermore, the strategic use of aluminum and iron introduces a robust alternative for creating structurally stable and durable furniture that remains lightweight enough for a kindergarten setting. Consequently, this study marks a significant shift from static furniture paradigms toward dynamic and adaptive educational systems. Nevertheless, this research acknowledges certain limitations, particularly regarding long-term durability testing. Such evaluations are critical in design experiments to ensure that solutions remain functional, relevant, and safe over extended periods of use [21]. Prospective studies should investigate the long-term resilience of the telescopic mechanism and assess potential mechanical risks from repetitive operation. Future research is encouraged to explore automated locking systems, material fatigue analysis, and the integration of sensor technology for real-time safety monitoring. Such advancements would expand the role of transformational desks from mere furniture pieces into components of an interaction-based smart learning ecosystem.

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References

1. J. Piaget, The Psychology of the Child. New York, NY, USA: Basic Books, 1969.
2. M. Montessori, The Absorbent Mind. New York, NY, USA: Holt, Rinehart and Winston, 1967.
3. D. A. Kroemer and K. H. E. Kroemer, Office Ergonomics. London, UK: Taylor & Francis, 2010.
4. M. Valikhani, R. Ibrahim, and M. S. Dolah, "The influences of furniture on children's health and well-being at primary school," J. Teknologi, vol. 82, no. 2, pp. 89–97, 2020.
5. B. Iliev, D. Domljan, and Z. Vlaović, "Comparison of anthropometric dimensions of preschool children and chairs in kindergartens," Heliyon, vol. 9, no. 3, 2023.
6. Z. I. Khairuni et al., "Application of ergonomic architecture in child-friendly furniture design," Sinektika, vol. 22, no. 1, pp. 45–52, 2025.
7. A. Andrianawati and V. Haristianti, "Desain interior interaktif ruang kelas TK berbasis ergonomi anak," Ekalaya, vol. 2, no. 3, pp. 120–132, 2023.

8. D. A. Norman, The Design of Everyday Things, Rev. ed. New York, NY, USA: Basic Books, 2013.
9. E. B.-N. Sanders and P. J. Stappers, Convivial Toolbox: Generative Research for the Front End of Design. Amsterdam, The Netherlands: BIS Publishers, 2012.
10. ISO 9241-210, Ergonomics of Human-System Interaction – Human-Centred Design for Interactive Systems. Geneva, Switzerland: International Organization for Standardization, 2019.
11. D. A. Kroemer dan K. H. E. Kroemer, Office Ergonomics. London, UK: Taylor & Francis, 2010.
12. E. K. Jensen and L. A. Skibsted, "The role of physical boundaries in enhancing children's focused play activities," Early Childhood Education Journal, vol. 49, no. 3, pp. 417–426, 2021.
13. S. Pheasant and C. M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, 3rd ed. Boca Raton, FL, USA: CRC Press, 2016.
14. A. R. Putra, I. W. Santosa, and D. W. Nugraha, "Structural performance of lightweight metal materials in modular educational furniture," Journal of Engineering and Applied Sciences, vol. 14, no. 9, pp. 3128–3135, 2019.
15. Y. Rogers, H. Sharp, and J. Preece, Interaction Design: Beyond Human–Computer Interaction, 5th ed. Hoboken, NJ, USA: Wiley, 2023.
16. D. L. Davies and L. Gu, "Flexible learning environments and early childhood engagement: A systematic review," Learning Environments Research, vol. 23, no. 3, pp. 421–439, 2020.
17. J. Piaget, The Psychology of the Child. New York, NY, USA: Basic Books, 1969.
18. L. S. Vygotsky, Mind in Society: The Development of Higher Psychological Processes. Cambridge, MA, USA: Harvard University Press, 1978.
19. R. Norman, "Transformable furniture design for educational environments," International Journal of Industrial Design, vol. 11, no. 2, pp. 89–98, 2018.
20. C. Chalik and I. K. Mukti, "Perancangan Rak Buku Modular Sekolah Dasar dengan Metode User-Centered Design (UCD)," Waca Cipta Ruang: Jurnal Ilmiah Desain Interior, vol. 10, no. 2, Nov. 2024
21. A. Atamtajani and C. Chalik, Eksperimen Desain: Strategi Inovatif dalam Penelitian dan Pengembangan Produk. Bandung, Indonesia: Tel-U Press, 2024.