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Empowering inclusive education through the design of supportive outdoor spaces

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ABSTRACT

This community service project was conducted to address the limited inclusivity and accessibility of outdoor learning environments at SLB YPAC Surabaya, a special needs school in Indonesia. The objective was to design inclusive front yard and central courtyard spaces that support educational, therapeutic, and social activities for students with diverse disabilities. The project provided the school with two conceptual, ready-to-implement design proposals developed through a participatory process. A qualitative, participatory approach was used, involving site observations, spatial analysis, and a Focus Group Discussion (FGD) with school stakeholders. Data gathered informed design solutions based on universal design principles and multisensory accessibility. The front yard design includes guiding blocks, inclusive waiting areas, and accessible circulation routes, while the central courtyard features a multisensory interaction zone with rubber flooring, therapeutic paths, tactile walls, and shaded resting areas. Both designs address key accessibility, comfort, and learning needs identified through FGD. This project shows that inclusive spatial planning, even without physical implementation, can generate practical and meaningful outcomes. The designs not only align with universal design theory but also reflect the real needs of users, offering a foundation for inclusive educational infrastructure that can be replicated in similar school contexts.

Kata Kunci
Disabilitas
Desain inklusif
Ruang terbuka

Memberdayakan pendidikan inklusif melalui desain ruang luar yang mendukung*. Proyek pengabdian masyarakat ini dilaksanakan untuk meningkatkan inklusivitas dan aksesibilitas ruang belajar luar ruang di SLB YPAC Surabaya, sebuah sekolah luar biasa yang melayani siswa dengan beragam jenis disabilitas. Melalui pendekatan kualitatif dan partisipatif, proses perancangan dilakukan dengan observasi lapangan, analisis spasial, serta Focus Group Discussion (FGD) bersama guru, terapis, dan pengelola sekolah. Data yang diperoleh digunakan untuk merumuskan solusi desain yang berlandaskan prinsip desain universal dan aksesibilitas multisensori, sehingga mampu menjawab kebutuhan nyata para pengguna. Proyek ini menghasilkan dua usulan desain konseptual. Pada halaman depan, rancangan mencakup blok pemandu, area tunggu inklusif, serta jalur sirkulasi yang aman dan aksesibel bagi pengguna kursi roda maupun siswa dengan hambatan visual. Sementara itu, halaman tengah diusulkan sebagai zona interaksi multisensori yang mendukung kegiatan edukatif dan terapeutik, dengan elemen seperti lantai karet, jalur terapi, dinding taktil, area istirahat teduh, serta ruang interaksi sosial yang nyaman. Meskipun belum diwujudkan secara fisik, kedua desain ini memberikan kontribusi praktis bagi pengembangan infrastruktur pendidikan inklusif. Proyek ini membuktikan bahwa perencanaan ruang yang sensitif terhadap kebutuhan disabilitas dapat menjadi dasar penting bagi sekolah lain dalam menciptakan lingkungan belajar yang aman, nyaman, dan setara bagi semua siswa.*

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INTRODUCTION

Inclusive education increasingly recognizes the importance of environments beyond traditional classrooms in supporting all learners, especially those with disabilities (Utami & Putra, 2020). Yet in many schoolyards, parks, and outdoor learning areas, physical and sensory barriers continue to limit access and participation for children with physical, cognitive, and neurodevelopmental challenges. Uneven ground surfaces, lack of ramps or handrails, overstimulating environments, and equipment that fails to accommodate diverse abilities contribute to exclusion and reduced engagement. Previous research highlights the extent to which non inclusive outdoor spaces hinder educational inclusion and social development (Woolley, 2013; Xie & Yuan, 2022). The negative implications of inaccessible schoolyards for children's psychological well-being and academic performance. The continued lack of inclusive design in outdoor educational environments presents a critical gap in achieving the full vision of inclusive education.

Several solutions have emerged through the application of Universal Design and Universal Design for Learning, aiming to provide flexible, accessible, and engaging spaces for diverse learners (Dalton et al., 2019; Davis et al., 2022). Multisensory gardens, textural walking paths, accessible seating arrangements, and inclusive play equipment are among the practical innovations proposed in the literature. These features have been shown to enhance autonomy, encourage interaction, and improve learning outcomes, especially when implemented through participatory processes involving teachers, students, and families. The educational and therapeutic benefits of sensory-rich environments (Efstathiou, 2021; Yetisgin et al., 2020). In community service contexts, it is essential to recognize the importance of involving children and local communities in shaping their environments. Such participation not only empowers individuals but also strengthens the relevance and impact of community initiatives. Although strategies that promote engagement and shared decision-making are promising, their implementation within community service programs often remains fragmented. In many cases, these efforts are not fully integrated with curriculum goals or aligned with the cultural contexts of the communities they aim to serve. As a result, the potential benefits of community involvement are not fully realized.

The current body of knowledge provides a strong foundation for understanding the value of inclusive outdoor spaces in educational settings. Developmental and cognitive benefits of nature-based outdoor learning (Woolley, 2013; Xie & Yuan, 2022). The role of natural play areas in promoting physical fitness and creativity among children (Kiviranta et al., 2024; Szczytko et al., 2018). Theories such as place-based learning by Sobel and sensory design approaches by Classen provide conceptual tools for aligning educational environments with children's sensory and cognitive needs. Successful community-based initiatives like the Boston Schoolyard Initiative and Denver Urban Gardens offer useful case studies in transforming underused outdoor areas into inclusive learning environments (Litt et al., 2023; Lopez et al., 2008). However, these examples rarely combine all necessary components into a unified model. In particular, few initiatives bridge inclusive design principles, community participation, and explicit alignment with educational objectives in one coherent process.

This reveals a clear gap in both theory and practice. While many projects focus on either physical accessibility, participatory engagement, or educational relevance, rarely do they integrate all three dimensions into one comprehensive framework. In Southeast Asia and other regions with limited resources particulary in metropolitan city such as Surabaya, there is a lack of community-based service programs that actively involve users with disabilities in co-creating inclusive learning spaces that reflect local cultures and pedagogical goals. This program aims to fill that gap by creating an inclusive outdoor learning design model that merges universal design strategies with local stakeholder engagement and direct alignment to learning outcomes. Its originality lies in the combination of sensory-inclusive features, co-design workshops, and field implementation that collectively respond to both physical and pedagogical needs of students with disabilities.

The program's primary contribution is the development and validation of a practical and replicable model for designing inclusive outdoor learning environments in special education contexts. The program is implemented at SLB YPAC Surabaya, an institution serving children with diverse physical, cognitive, and sensory needs. This initiative aligns with global commitments to the Sustainable Development Goals (SDGs), particularly SDG 4 on Quality Education and SDG 10 on Reducing Inequalities.

Through participatory workshops and prototyping sessions within the school environment, the program engages teachers, therapists, school administrators, students, and families as active partners in the design process. This collaborative approach strengthens the school community's capacity to create learning spaces that are equitable, accessible, and relevant to the lived experiences of children with disabilities. Furthermore, the integration of multisensory design elements supports the creation of a safe, inclusive, and sustainable school environment, in line with SDG 11 on Sustainable Cities and Human Settlements.

Each spatial feature is designed with a link to specific learning objectives, such as motor development, sensory regulation, communication, and social interaction, so that the physical environment serves as an integral part of the learning process. The resulting outdoor space enhances accessibility, sensory engagement, and opportunities for social inclusion and emotional well-being. Ultimately, this program demonstrates that inclusive education must be embodied in the physical environment where learning takes place, so that the principles of equality, participation, and dignity can be present in every aspect of the learning experience at SLB YPAC Surabaya.

METHOD

This community service project adopted a qualitative, participatory design methodology based on the principles of Universal Design (UD), Universal Design for Learning (UDL), and inclusive spatial planning (Dalton et al., 2019; Davis et al., 2022). This approach was chosen to ensure that the resulting design truly reflects the needs and lived experiences of students with disabilities, their educators, and caregivers. By directly engaging the target community, the project aimed to produce an outdoor learning environment that was inclusive, accessible, sensory-rich, and educationally valuable. While not including the physical construction phase, the design phase was systematically structured to maintain relevance and future applicability.

The project was implemented between March and June 2024 in collaboration with SLB YPAC Surabaya, a special education institution serving students with various disabilities, including intellectual, physical, and sensory disabilities (Fatoni et al., 2022; Prasetyowati et al., 2023). The school was selected for its diverse student population, commitment to inclusive education, and openness to participatory engagement. There was no formal memorandum of understanding (MoU), but coordination was conducted through informal agreements between the project team and the school.

Participant demographics consisted of approximately 45 students aged 7–18 with varying special needs (blindness, deafness, intellectual disabilities, cerebral palsy, and other sensory needs). 12 teachers and therapists with 3–25 years of experience in special education. 3 administrative staff involved in the management of facilities and outdoor activities.

Research Ethics

Prior to the start of the activity, written consent was obtained from the school and parental/guardian consent to involve students in data collection activities. Student participation was voluntary, with simplified communication procedures and teacher guidance allowing students to choose whether or not to participate without pressure. All activities were designed to be safe, non-invasive, and mimic everyday learning activities.

The collected data, including observation notes, environmental photographs (without showing students' faces), and interview transcripts were stored in an encrypted digital folder and accessible only to the research team. All participant identities were anonymized in all reports and published materials.

Data were analyzed using a thematic coding approach, beginning with open coding to identify initial patterns, followed by axial coding to group themes related to accessibility needs, sensory preferences, and pedagogical practices. Data sources were triangulated by comparing observations, teacher/therapist interviews, and student participatory mapping activities to increase the reliability of the findings.

Implementation Stages

The project consisted of four main phases: (1) initial assessment, (2) user-centered data collection, (3) participatory design development, and (4) conceptual design package development.

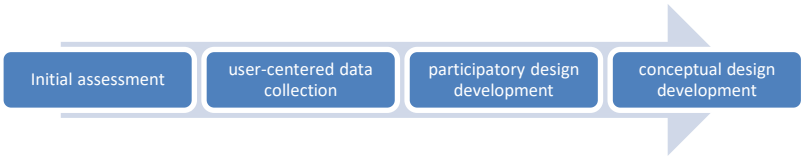

Figure 1. Phases of community service

In the initial assessment phase, the team observed the physical condition of the outdoor space, accessibility barriers, and space use patterns. Measurements of dimensions, materials, circulation routes, and environmental factors such as noise, lighting, and tactile elements were also documented.

During the data collection phase, structured interviews and informal discussions were conducted with teachers, therapists, and staff to understand the educational and therapeutic goals of outdoor learning. Focus groups and simple mapping tasks were conducted with students, with teacher support to ensure friendly and understandable communication.

The participatory design development phase involved translating the collected data into inclusive spatial concepts that aligned with the school's educational needs (Araghi et al., 2023). A series of design proposals were developed using principles of multisensory engagement, physical accessibility, and psychological comfort. These included zones for exploration, quiet reflection, social interaction, and therapeutic activities. Draft designs were reviewed by the school team in an informal feedback session, during which staff provided input on layout, materials, maintenance concerns, and

educational alignment. This iterative feedback informed the final design proposal, which was adapted to reflect the site's constraints and opportunities.

The final phase consisted of preparing and delivering a complete conceptual design package to SLB YPAC Surabaya. The package included detailed layout plans, 3D visualizations, materials recommendations, and guidelines for future implementation. Although physical construction was not part of the project scope, the design was developed to be immediately actionable if future funding or institutional support becomes available. The participatory process and site-specific documentation ensured the proposal's relevance, feasibility, and alignment with inclusive education goals. This method allows readers and stakeholders to evaluate the project's validity and reliability based on transparent procedures, stakeholder engagement, and the use of established inclusive design frameworks.

RESULTS AND DISCUSSION

In conclusion, this community service project successfully generated two inclusive outdoor space design proposals for SLB YPAC Surabaya, focusing on the front yard and central courtyard, in response to critical spatial, sensory, and accessibility challenges experienced by students with disabilities (Warutkar & Krishna Kovela, 2022). Although the designs have not been physically implemented, they offer concrete, evidence-based, and context-sensitive solutions grounded in universal design principles and inclusive architectural practice. Importantly, both design proposals were developed and refined through a participatory process that included a Focus Group Discussion (FGD) involving school leaders, teachers, therapists, and staff at SLB YPAC Surabaya (Figure 2). This discussion provided valuable feedback and validation of the design concepts, ensuring that they addressed not only physical accessibility but also educational functionality and user comfort (Indrizal, 2014). The front yard redesign proposed guiding blocks, inclusive waiting areas, and accessible drop-off zones, while the central courtyard was transformed into a multisensory interaction oasis that supports therapy, learning, and play. The integration of tactile, visual, and auditory elements demonstrates a holistic approach to inclusive design (Senjana et al., 2021; Zairuddin et al., 2020). Moreover, the FGD process served as a platform for mutual learning and awareness building, empowering school stakeholders to envision a more inclusive spatial environment. These designs outcomes align with international best practices yet remain adaptable to the local context, making them suitable for phased implementation and replication in other special education settings. Overall, this project affirms that inclusive spatial planning, even in the form of a conceptual design, can be a powerful driver of educational transformation when supported by community engagement and interdisciplinary collaboration (Hussein, 2012; Mualli et al., 2022).

Figure 2. FGD with stakeholders

The main findings in the front yard included inadequate pedestrian infrastructure, lack of sensory orientation features, insufficient shading, and unsegregated vehicle and pedestrian circulation. For students with mobility aids, the absence of ramps with correct slope, smooth paving, and guiding blocks presented daily challenges in movement and navigation (Qiu et al., 2023). Furthermore, the lack of visual signage and tactile cues rendered the space (Figure 3) cognitively and sensorily inaccessible to students with visual impairments and developmental disabilities.

Figure 3. The Existing Yard

In response to these issues, the design introduced a new spatial layout that emphasized safe and inclusive circulation. This included clearly defined drop-off zones, widened walkways with smooth, non-slip surfaces, the installation of guiding blocks, and visual cues for wayfinding (Figure 4). These interventions were carefully designed to comply with universal design standards and aimed to improve independent navigation and comfort for all users.

Figure 4. Adding the guide block

Meanwhile, the design of the central courtyard addressed a different but complementary set of challenges. The courtyard, originally covered in uneven and slippery natural grass, lacked defined activity zones and was uncomfortable during extreme weather conditions due to the absence of shade or protection from rain (Figure 5). This space, although large and centrally located, was significantly underused by students and teachers. The redesign reconceptualized the courtyard into what the team called a multisensory interaction oasis. The new design transformed the courtyard into a multifunctional space with distinct zones for adaptive play, physical therapy, sensory exploration, and social interaction (Araghi et al., 2023; Baharian et al., 2023; Hussein, 2012; Mualli et al., 2022). Key features included rubber flooring for safety and sensory input (Thompson et al., 1998), guiding blocks for navigational support (Israd i et al., 2020; Rahmat, 2021), and modular shading structures made from polycarbonate material that allow natural light while protecting from heat and rain.

Figure 5. Existing courtyard

In terms of sensory and therapeutic integration, the courtyard design took an innovative approach by introducing interactive installations such as sensory walls, kinetic-textured stepping areas, auditory feedback devices, and colorful visual play elements (Figure 6). These features were specifically included to support students with sensory processing disorders, autism, ADHD, and other developmental challenges (Ghani, 2020; Stroes et al., 2003; Vargas et al., 2002). The intention was to allow children to experience space through a combination of touch, sound, sight, and proprioception, encouraging spontaneous exploration and engagement (Araghi et al., 2023; Baharian et al., 2023; Hussein, 2012; Warutkar & Krishna Kovela, 2022). The design also included protective nets around zones used for physical activity to ensure safety without visually isolating the space (Zhang et al., 2021). This holistic sensory approach reflects current best practices in inclusive design and represents a shift from traditional flat open fields to purpose-built, multisensory outdoor classrooms.

Figure 6. Sensory and therapeutic integration

The inclusion of clearly defined spatial functions in both areas offers significant improvements in spatial legibility and usability. For example, the front yard now features an inclusive waiting area which functions as a transition zone where students, caregivers, and visitors can regulate themselves before entering indoor spaces. This element was informed by literature emphasizing the importance of threshold or buffer spaces in inclusive environments. Similarly, the courtyard now incorporates a therapeutic rehabilitation area, carefully planned with appropriate spacing, ramp gradients, and durable materials that support a range of therapeutic equipment and movement-based activities (Qiu et al., 2023). This area also features sensory gardens and shaded benches, providing opportunities for rest and quiet reflection which are essential for students with high sensory sensitivities.

Comparing these results with previous studies further validates the design strategies employed. The importance of integrating sensory stimuli in outdoor learning environments, while Woolley emphasizes the need for navigation tools such as tactile paving and color contrast to support wayfinding (Senjana et al., 2021; Warutkar & Krishna Kovela, 2022). The inclusion of features like guiding blocks, grab bars, and interactive walls directly aligns with such findings. The front yard redesign regarding the frequent lack of inclusive infrastructure in school entrance zones. Meanwhile, the courtyard design goes a step further by not only addressing physical barriers but also enhancing educational potential through interactive sensory features, making it a model for inclusive schoolyard redevelopment in resource-limited urban settings.

The implications of these findings are multidimensional. Functionally, the redesigned areas provide safe and independent mobility routes, adaptable learning environments, and engaging play experiences for all students regardless of ability. Educationally, these spaces allow teachers to expand their pedagogical approaches by incorporating outdoor sensory activities that support cognitive, physical, and emotional development. Socially, the presence of shared inclusive environments reduces stigma and promotes positive interaction among students with and without disabilities (Fu et al., 2022; Haakma et al., 2021; Qi & Wang, 2018). Psychologically, the combination of calm zones and active areas respects individual regulation needs, particularly for students with autism spectrum conditions or anxiety-related behaviors, offering them spaces to decompress or engage at their own pace.

Another critical implication lies in institutional awareness and capacity-building. Even though the project stopped at the design stage without implementation, the participatory process involved in developing the design has already increased the school's awareness of inclusive spatial practices. Teachers and staff reported a deeper understanding of spatial needs and expressed interest in applying the proposed design principles in other areas of the school. This indicates that well-researched and community-engaged design work can serve as both a product and a process of transformation, leading to more inclusive attitudes and long-term institutional change, even in the absence of immediate construction.

From a methodological perspective, the design-only approach enabled a deeper focus on documentation, feedback, and conceptual clarity without the pressure of budget or material constraints (Braun & Clarke, 2021; Jaakkola, 2020; Moreno et al., 2016). This allowed for a more comprehensive design narrative that schools and stakeholders can refer to when seeking funding or support for phased implementation. The detailed documentation included layout plans, spatial analysis, material recommendations, and accessibility guidelines, making the proposal a practical tool for future development. Additionally, the proposals can serve as a transferable model for other special education schools with similar needs and spatial limitations.

Design for the front yard and central courtyard at SLB YPAC Surabaya successfully addressed the research problems stated in the introduction. They transformed underperforming outdoor areas into inclusive, multifunctional, and educational spaces that align with universal design principles. Although these proposals were not physically implemented, their value lies in the strategic, participatory, and inclusive thinking that guided their creation. The results demonstrate that with careful analysis and community involvement, spatial design can be a powerful instrument to support inclusive education and promote equal access to meaningful learning experiences for all children.

CONCLUSION

In conclusion, this community service project successfully produced two inclusive outdoor space design proposals for SLB YPAC Surabaya, focusing on the front yard and central courtyard, as a response to the identified spatial and sensory barriers faced by students with disabilities. Although the designs were not implemented physically, they offer actionable, evidence-based, and contextually grounded solutions rooted in universal design and inclusive architectural principles. The front yard redesign addressed accessibility, navigation, and comfort through elements such as guiding blocks, inclusive waiting areas, and improved circulation, while the central courtyard was transformed conceptually into a multisensory interaction oasis that supports play, therapy, and sensory development. These outcomes reflect current international standards in inclusive educational environments while adapting them to the specific cultural and physical context of a special education school in Indonesia. The process fostered awareness and capacity among educators and stakeholders, demonstrating that design itself can be a meaningful form of intervention. As a whole, this project underscores the critical role of inclusive spatial planning in supporting holistic learning, and it provides a replicable model that can inspire similar initiatives in other educational institutions across the region.

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REFERENCES

Araghi, N. M., Azari, Z. P., Zarei, M. A., Baghban, A. A., Saei, S., Nodeh, H. R. Y., Farshbafkhalili, A., & Mahmoudi, E. (2023). The relationship between sensory processing patterns and participation in childhood leisure and play activities: A systematic review and meta-analysis. In *Iranian Rehabilitation Journal* (Vol. 21, Issue 1). https://doi.org/10.32598/irj.21.1.1277.2

Baharian, N., Raji, P., Alizadeh Zarei, M., & Baghestani, A. R. (2023). Effectiveness of a sensory play activity program with parent engagement for children with autism spectrum disorder: A randomized control trial. *Iranian Journal of Psychiatry and Behavioral Sciences*, *17*(4). https://doi.org/10.5812/ijpbs-136750

Braun, V., & Clarke, V. (2021). Conceptual and design thinking for thematic analysis. *Qualitative Psychology*, *9*(1). https://doi.org/10.1037/qup0000196

Dalton, E. M., Lyner-Cleophas, M., Ferguson, B. T., & McKenzie, J. (2019). Inclusion, universal design and universal design for learning in higher education: South Africa and the United States. *African Journal of Disability*, *8*. https://doi.org/10.4102/ajod.v8i0.519

Davis, D., McLaughlin, M. K., & Anderson, K. M. (2022). Universal design for learning. *Nurse Educator*, *47*(3). https://doi.org/10.1097/NNE.0000000000001116

Efstathiou, G. (2021). The therapeutic relationship in cognitive behavioral therapy. *Psychology*, *26*(2). https://doi.org/10.12681/psy_hps.26862

Fatoni, M. H., Suprayitno, E. A., Arifin, A., Hikmah, N. F., Sardjono, T. A., & Nuh, M. (2022). Pemanfaatan kursi roda elektrik dengan kendali joystick guna meningkatkan kemandirian siswa berkebutuhan khusus di sekolah luar biasa D Yayasan Pembinaan Anak Cacat Surabaya. *Sewagati*, *7*(2). https://doi.org/10.12962/j26139960.v7i2.446

Fu, W., Liang, J., Wang, L., Xu, R., & Xiao, F. (2022). Teacher-student interaction in a special school for students with developmental disabilities in Chinese context. *International Journal of Developmental Disabilities*, *68*(2). https://doi.org/10.1080/20473869.2020.1729018

Ghani, M. Z. (2020). Dimensions of learning styles among students with attention deficit-hyperactivity disorder (ADHD) in Malaysia. *ASEAN Journal of Open Distance Learning*, *12*(1).

Haakma, I., De Boer, A. A., Van Esch, S., Minnaert, A. E. M. G., & Van Der Putten, A. A. J. (2021). Inclusion moments for students with profound intellectual and multiple disabilities in mainstream schools: The teacher assistant's role in supporting peer interactions. *European Journal of Special Needs Education*, *36*(2). https://doi.org/10.1080/08856257.2021.1901374

Hussein, H. (2012). The influence of sensory gardens on the behaviour of children with special educational needs. *Procedia - Social and Behavioral Sciences*, *38*, 343–354. https://doi.org/10.1016/j.sbspro.2012.03.356

Indrizal, E. (2014). Diskusi kelompok terarah focus group discusion (FGD). *Jurnal Antropologi: Isu-Isu Sosial Budaya*, *16*(1).

Isradi, M., Hidayat, A., & Prasetijo, J. (2020). Guiding paving block porous for blind people. *HOLISTICA – Journal of Business and Public Administration*, *11*(1). https://doi.org/10.2478/hjbpa-2020-0007

Jaakkola, E. (2020). Designing conceptual articles: four approaches. *AMS Review*, *10*(1–2). https://doi.org/10.1007/s13162-020-00161-0

Kiviranta, L., Lindfors, E., Rönkkö, M. L., & Luukka, E. (2024). Outdoor learning in early childhood education: exploring benefits and challenges. In *Educational Research* (Vol. 66, Issue 1). https://doi.org/10.1080/00131881.2023.2285762

Litt, J. S., Alaimo, K., Harrall, K. K., Hamman, R. F., Hébert, J. R., Hurley, T. G., Leiferman, J. A., Li, K., Villalobos, A., Coringrato, E., Courtney, J. B., Payton, M., & Glueck, D. H. (2023). Effects of a community gardening intervention on diet, physical activity, and anthropometry outcomes in the USA (CAPS): an observer-blind, randomised controlled trial. *The Lancet Planetary Health*, *7*(1). https://doi.org/10.1016/S2542-5196(22)00303-5

Lopez, R., Campbell, R., & Jennings, J. (2008). The Boston schoolyard initiative: A public-private partnership for rebuilding urban play spaces. In *Journal of Health Politics, Policy and Law* (Vol. 33, Issue 3). https://doi.org/10.1215/03616878-2008-010

Moreno, M., De los Rios, C., Rowe, Z., & Charnley, F. (2016). A conceptual framework for circular design. *Sustainability (Switzerland)*, *8*(9). https://doi.org/10.3390/su8090937

Mualli, C., Rofiki, Moh., Listrianti, F., Vinori, M. J., & Muhaiminah, M. (2022). Concentration of children's learning in motor-sensory play management development framework. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *6*(5). https://doi.org/10.31004/obsesi.v6i5.2140

Prasetyowati, S., Isnanto, I., & Pipit R, A. (2023). Improving oral hygiene maintenance through teacher empowerment to reduce the debris index of children with disabilities. *International Journal of Advanced Health Science and Technology*, *3*(1). https://doi.org/10.35882/ijahst.v3i1.211

Qi, J., & Wang, L. (2018). Social interaction between students with and without disabilities in general physical education: a Chinese perspective. *Physical Education and Sport Pedagogy*, *23*(6). https://doi.org/10.1080/17408989.2018.1485139

Qiu, N., Zhang, T., & Cheng, J. (2023). Examining the impact of spatial accessibility to rehabilitation facilities on the degree of disability: A heterogeneity perspective. *SSM - Population Health*, *23*. https://doi.org/10.1016/j.ssmph.2023.101489

Rahmat, A. (2021). Creating good environment and building for people with special needs: from definition to application of guiding and warning blocks. *Indonesian Journal of Community and Special Needs Education*, *2*(1). https://doi.org/10.17509/ijcsne.v2i1.41584

Senjana, S., Alfa, G., & Putra, S. (2021). *Landscape Design: Pattern and Color in Sensory Garden for Disability Justice*.

Stroes, A., Alberts, E., & Van Der Meere, J. J. (2003). Boys with ADHD in social interaction with a nonfamiliar adult: An observational study. *Journal of the American Academy of Child and Adolescent Psychiatry*, *42*(3). https://doi.org/10.1097/00004583-200303000-00009

Szczytko, R., Carrier, S. J., & Stevenson, K. T. (2018). Impacts of outdoor environmental education on teacher reports of attention, behavior, and learning outcomes for students with emotional, cognitive, and behavioral disabilities. *Frontiers in Education*, *3*. https://doi.org/10.3389/feduc.2018.00046

Thompson, R. C., Hilton, T. F., & Witt, L. A. (1998). Where the safety rubber meets the shop floor: a confirmatory model of management influence on workplace safety. *Journal of Safety Research*, *29*(1). https://doi.org/10.1016/S0022-4375(97)00025-X

Utami, M. N., & Putra, W. B. (2020). Fasilitas ruang khusus pada sekolah inklusi binar Indonesia (Bindo) di Bandung. *Jurnal Arsitektur TERRACOTTA |*, *2*(1), 34–43.

Vargas, A. U., Zentall, S. S., Wilbur, J. D., & Vargas, A. U. (2002). Responses to art attention-training by english and bilingual spanish-speaking students with and without ADHD. *Studies in Art Education*, *43*(2). https://doi.org/10.2307/1321002

Warutkar, V. B., & Krishna Kovela, R. (2022). Review of sensory integration therapy for children with cerebral palsy. *Cureus*. https://doi.org/10.7759/cureus.30714

Woolley, H. (2013). Now being social: The barrier of designing outdoor play spaces for disabled children. *Children and Society*, *27*(6). https://doi.org/10.1111/j.1099-0860.2012.00464.x

Xie, Q., & Yuan, X. (2022). Functioning and environment: Exploring outdoor activity-friendly environments for older adults with disabilities in a Chinese long-term care facility. *Building Research and Information*, *50*(1–2). https://doi.org/10.1080/09613218.2021.1968292

Yetisgin, A. A., Cetinel, S., Zuvin, M., Kosar, A., & Kutlu, O. (2020). Therapeutic nanoparticles and their targeted delivery applications. In *Molecules* (Vol. 25, Issue 9). https://doi.org/10.3390/molecules25092193

Zairuddin, N. S., Othman, N., & Abdul Malek, N. (2020). A Review on tree sensitive urban design (TSUD) approach as potentials streetscape design guidelines. *Environment-Behaviour Proceedings Journal*, *5*(13), 215–221. https://doi.org/10.21834/e-bpj.v5i13.2086

Zhang, Z., Qian, Q., Wang, J., Liu, H., Liang, K., Li, Z., & Liu, G. (2021). Study of passive protective net protecting the rockfall caused by open-pit blasting on high and steep slope. *Shock and Vibration*, *2021*. https://doi.org/10.1155/2021/4577889