

## The Implementation of Universal Design in Classroom Spaces A Case Study at President Special Needs Center

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ARTICLE INFORMATION	ABSTRACT
<p>Received 06-10-2025 Accepted 21-11-2025 Published 01-04-2026</p> <hr/> <p><b>Keywords:</b> Accessibility, classroom design, inclusive education, special needs education, universal design.</p>	<p>Inclusive education ensures equal access for all learners, including those with special needs. Universal Design (UD) offers a framework for creating safe, supportive, and participatory learning environments. This study evaluates the implementation of UD principles at the President Special Needs Center (PSNC) in Cikarang across four classrooms—Sun, Mercury, Venus, and Earth—categorized by students' developmental levels. Data were collected through observations, visual documentation, and questionnaires from 20 respondents (teachers, parents, and architecture students). The analysis applied seven UD principles using a 1-4 Likert scale. Results show uneven application of UD. Sun and Mercury Classrooms scored higher in Tolerance for Error, Flexibility in Use, and Perceptible Information, indicating better support for students with mild to moderate needs. Venus and Earth Classrooms scored lower in Perceptible Information, Low Physical Effort, and Size and Space for Approach and Use, revealing challenges for students with more complex conditions. Overall, UD has been implemented at PSNC, but improvements in information clarity, ergonomics, and spatial accessibility are needed to achieve more inclusive learning environments.</p>
<p><b>Kata kunci:</b> <i>Aksesibilitas, desain kelas, desain universal, pendidikan inklusif, pendidikan kebutuhan khusus.</i></p>	<p><b>ABSTRAK</b></p> <p><b>Judul: Implementasi Desain Universal pada Ruang Kelas: Studi Kasus di President Special Needs Center</b></p> <p><i>Pendidikan inklusif menjamin akses yang setara bagi seluruh peserta didik, termasuk anak berkebutuhan khusus. Universal Design (UD) menawarkan pendekatan untuk mewujudkan lingkungan belajar yang aman, suportif, dan partisipatif. Penelitian ini bertujuan mengevaluasi penerapan prinsip UD di President Special Needs Center (PSNC) Cikarang pada empat ruang kelas—Sun, Mercury, Venus, dan Earth—yang diklasifikasikan berdasarkan tingkat perkembangan siswa. Data dikumpulkan melalui observasi, dokumentasi visual, dan kuesioner kepada 20 responden (guru, orang tua, dan mahasiswa arsitektur). Analisis menggunakan tujuh prinsip UD dengan skala Likert 1–4. Hasil menunjukkan penerapan UD yang belum merata. Kelas Sun dan Mercury memperoleh skor lebih tinggi pada prinsip Tolerance for Error, Flexibility in Use, dan Perceptible Information. Sebaliknya, kelas Venus dan Earth menunjukkan skor lebih rendah pada Perceptible Information, Low Physical Effort, serta Size and Space for Approach and Use. Secara umum, UD telah diterapkan di PSNC, namun diperlukan peningkatan pada aspek kejelasan informasi, ergonomi, dan aksesibilitas ruang untuk mewujudkan lingkungan belajar yang lebih inklusif.</i></p>

## Introduction

Inclusive education has become a crucial issue in the global development agenda. The United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) affirms that every individual, including children with special needs, has the right to equal access to education without discrimination. In line with this, the Sustainable Development Goals (SDGs), particularly Goal 4 on Quality Education, emphasize inclusion and equitable access to education for all. Nevertheless, gaps in access to education for children with disabilities remain a major challenge in many countries, including Indonesia. Data indicate that nearly one-third of children with disabilities in Indonesia have not received formal education, while those who attend school often lack adequate support within their learning environment. This condition highlights a significant gap between regulations, policies, and their implementation in practice.

In the Indonesian context, the government has issued several regulations to promote inclusive education, such as the Ministry of National Education Regulation No. 70 of 2009 on Inclusive Education and Law No. 8 of 2016 on Persons with Disabilities. These regulations provide a strong legal foundation requiring schools to deliver equal educational services to all students. However, various studies report that implementation continues to face barriers, particularly in school infrastructure that is not disability-friendly, limited supporting facilities, and insufficient understanding among educators of the requirements for inclusive learning environments. For

instance, the absence of ramps, accessible toilets, and classrooms with adaptive designs has become a real obstacle to accessibility for children with special needs.

Universal Design offers an important approach to address these challenges. Introduced by Ronald Mace in 1997 at North Carolina State University, the concept emphasizes creating spaces and products accessible and usable by all people without the need for special modifications. The principles of Universal Design enable the creation of learning environments that are safe, comfortable, and inclusive for all students, including those with disabilities (Nurfiza et al., 2025; Pramesworo et al., 2025). The application of these principles also provides added value, as they not only benefit persons with disabilities but also enhance usability and support for all users in carrying out their activities.

In addition, the literature emphasizes that classroom design directly affects students' behavior, motivation, and achievement. The behavioral architecture approach highlights the importance of spaces that foster both physical and psychological comfort (Widyakusuma, 2020). This concept aligns with the Montessori method, which promotes child-friendly classroom design, proportional furniture, inspirational environments, and a homelike atmosphere that encourages independence and discipline (Rahmadani, 2021). The integration of Universal Design, behavioral architecture, and the Montessori method holds the potential to create learning spaces that are more inclusive, participatory, and adaptive to the diverse needs of students.

The President Special Needs Center (PSNC) in Cikarang is one of the educational centers established to meet the needs of children with special needs in the rapidly developing industrial and residential area (Figure 1). PSNC operates under the auspices of President University, which is committed to inclusivity and equal access to education for all segments of society. This institution focuses on providing educational services, therapy, and social support for children with special needs, including autism, Down syndrome, and other developmental disorders. Its classrooms and facilities are designed to support interactive learning, personalized teaching approaches, and social integration among students. Within this local context, PSNC serves as a relevant site for assessing the implementation of Universal Design principles in creating inclusive learning spaces in Indonesia.



**Figure 1. PSNC corridor**  
Source: Author's documentation, 2025

Empirical studies on the application of Universal Design in inclusive school settings in Indonesia remain limited

(Rafah et al., 2025). Most existing research has focused on policy issues or pedagogical services, while the design aspects of learning spaces have not been comprehensively explored. Yet, learning environments that are not designed with inclusive principles can pose significant barriers to the full participation of children with special needs (Atika, 2024; Wardana, 2025).

Therefore, this study seeks to address this knowledge gap through a case study at the President Special Needs Center (PSNC) in Cikarang. Beyond mere evaluation, the findings of this research are intended to provide practical guidance for PSNC. These results can be utilized by the center as a foundation for continuous assessment and incremental design improvements. Consequently, this study offers a specific applicative contribution, aiding PSNC in achieving greater alignment with Universal Design principles to realize a learning environment that is genuinely universal for all students, regardless of their diverse disabilities.

### Principles of Universal Design

Universal Design (UD) originated from the disability rights movement and architectural accessibility developments that began in the 1950s in Europe, Japan, and the United States, a period when barrier-free design was first being explored to address the needs of people with disabilities. During the 1970s, the approach evolved from merely removing physical barriers toward integrating all people into an inclusive environment. Architect Ronald Mace, an industrial designer and wheelchair user since childhood due to polio, subsequently redefined this concept as a rational approach to creating designs usable by everyone without the need for special adaptation. In the 1980s, Mace formalized the term

Universal Design and expanded its application to environmental and product design. Legal milestones such as the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 strengthened its legal foundation, culminating in the pivotal 1997 achievement where Mace led a team of experts at North Carolina State University to establish the Seven Principles of Universal Design, which emphasize simplicity, intuitiveness, and tolerance for error (Table 1).

**Table 1. Universal Design principles**

No.	Principles	Description
1.	Equitable Use (EU)	Designs benefit all users without segregation or stigma
2.	Flexibility in Use (FU)	Allows variations in use according to user needs
3.	Simple and Intuitive (SI)	Easy to understand for all users
4.	Perceptible Information (PI)	Information is accessible in multiple ways
5.	Tolerance for Error (TE)	Minimizes risks of hazards caused by mistakes
6.	Low Physical Effort (LPE)	Comfortable to use without excessive exertion
7.	Size and Space for Approach and Use (SSAU)	Provides sufficient movement space for different postures and mobility needs

Source: Mace, 1998; Story et al., 1998

In practice, the application of these principles includes shared access doors for all students, wide circulation paths, adjustable desks and chairs, and information boards with symbols and color contrasts that are easy to interpret. International research has confirmed that inclusive design generates multiple benefits. For example, high-quality sound systems not only support students with hearing impairments but also enhance the overall learning experience for the entire classroom.

Previous studies highlight that implementing Universal Design presents varying challenges across contexts. Research at the Royal Pavilion in Brighton, United Kingdom, demonstrated that historic buildings can adapt to universal design principles to accommodate diverse users, although full accessibility remains limited (Amani & Sari, 2022). A study at the Geological Museum in Bandung revealed that the application of Universal Design has not yet been fully optimized, particularly regarding circulation facilities, elevators, and toilets, leaving accessibility for persons with disabilities still constrained (Indriastjario et al., 2018). Research at Samarendah Park in Samarinda also found that most facilities did not meet accessibility standards, especially in terms of tolerance for error and low physical effort, despite some positive practices such as ramps and pedestrian pathways (Noviana & Hidayati, 2020). Meanwhile, a study of Boncafe restaurant in Surabaya emphasized that although efforts to apply Universal Design principles were evident, further technical adjustments were needed to ensure inclusivity for all users (Limantoro, 2014). These findings affirm that inclusive design is not merely about adhering to technical standards but also about the social, psychological, and functional experiences of users when accessing public and educational spaces.

## Methods

This study employed a case study approach with the research site located at the President Special Needs Center (PSNC) in Cikarang. The research focused on four main classrooms used for daily learning activities, namely the Sun, Mercury, Venus, and Earth

Classrooms. These four spaces were selected because they represent the variation of functions within PSNC and serve as the core areas of students' daily learning activities.

Data were collected through field observation, visual documentation, questionnaires, and chart-based visual analysis. Observations were conducted to assess the physical conditions of each classroom, including layout, circulation paths, accessibility, furniture, and supporting facilities (Creswell & Poth, 2018). Visual documentation was used to record the spatial details of each classroom, enabling comparisons based on Universal Design parameters.

The questionnaire instrument was developed with reference to the seven principles of Universal Design formulated by the Center for Universal Design at NC State University (Mace, 1998; Story et al., 1998). These include Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, and Size and Space for Approach and Use. Each principle was translated into indicators adapted to the context of educational spaces. The assessment applied a four-point Likert scale, where 1 indicated strongly not aligned, and 4 indicated strongly aligned with Universal Design principles (Table 2).

**Table 2. Likert scale**

Score	Description
4	Strongly aligned
3	Aligned
2	Not aligned
1	Strongly not aligned

Source: (Wibowo, 2025)

The respondents comprised 10 active PSNC teachers, 5 parents, and 5 architecture students who evaluated the design's technical aspects. A total of 20

respondents provided assessments through questionnaires accompanied by observation guidelines. Quantitative data from the questionnaires were processed to generate average scores for each principle across the classrooms, while data from observations and visual documentation were used to enrich the findings with descriptive insights into spatial conditions. Triangulation was conducted by integrating perspectives from teachers, parents, and architecture students, resulting in a more comprehensive understanding of the implementation of Universal Design.

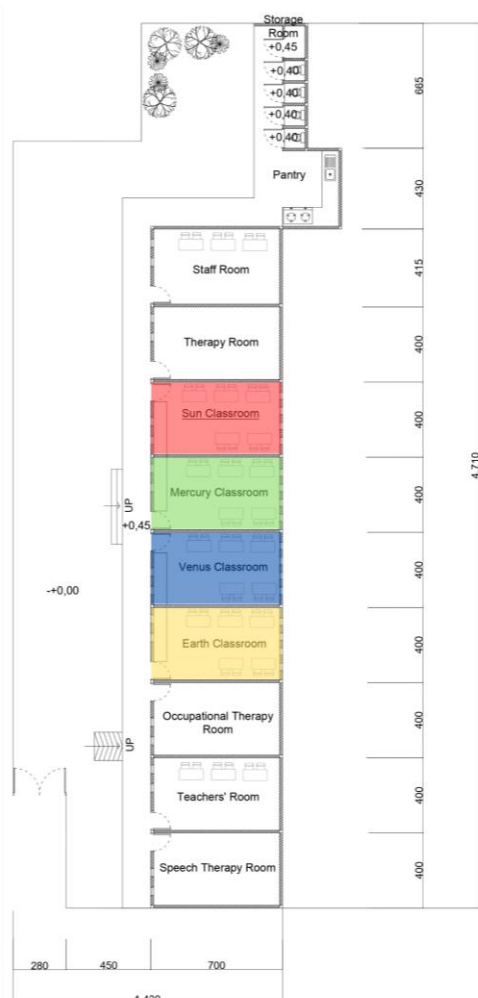
To support the interpretation of results, two types of visualizations were employed. First, radar charts were used because they can display multidimensional profiles in a single view, enabling identification of the strengths and weaknesses of each classroom in relation to the seven Universal Design principles (Santoso, 2020, p. 522). This visualization effectively enables comparative performance analysis of classrooms within the context of learning space design research. Second, a heatmap was used to display the distribution of average scores across classrooms and principles, with color gradations to facilitate the identification of both high- and low-scoring areas (Santoso, 2020; Wilkinson & Friendly, 2009). The combination of these two visualization techniques was considered essential, as radar charts provide a comprehensive profile of each classroom, while heatmaps quickly and intuitively highlight overall distribution patterns.

## Result and Discussions

### President Special Needs Center

President Special Needs Center (PSNC) is a division of Sekolah Presiden

supported by the President University Education Foundation (YPUP). PSNC provides three main services focused on the growth and education of children with special needs (Figure 2). There are four classifications of classrooms at the President Special Needs Center, organized from the lowest to the highest level according to the children's capabilities. The special needs center arranges classroom spaces based on students' developmental stages and specific conditions.



**Figure 2. PSNC Layout Plan**  
Source: Author's work and analysis, 2025

The Sun was the first service to offer clinical psychology for children, including developmental evaluations,

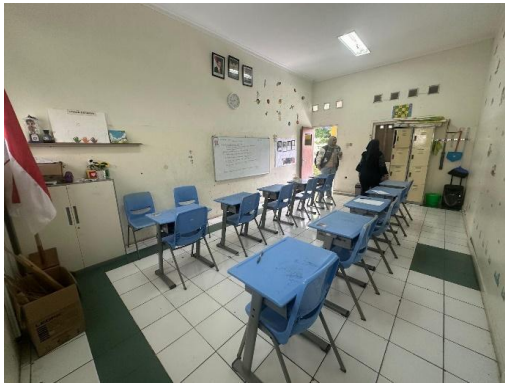
IQ tests, aptitude and interest tests, psychological assessments, school-readiness tests, and more. The second service is the treatment center, which includes occupational therapy/sensory integration, speech therapy, behavioral therapy, and special education. Finally, Special Needs Education provides Social Skills Classes (for children with special needs) and Calistung Tutoring.

Class serves as the foundational class for students with mild conditions such as mild autism, Down syndrome, and ADHD (Attention Deficit Hyperactivity Disorder). This class is designed to accommodate the initial learning needs of children requiring basic support. At the intermediate level, the Mercury Class focuses on students with autism, mild cerebral palsy, and learning disabilities. This class provides a more structured environment to support children who are progressing beyond the basics but still require specialized attention. For advanced-level students, the Venus Class accommodates those with moderate autism, moderate cerebral palsy, and general developmental disorders. The support in this class is designed to help students facing greater challenges continue their learning journey in a structured setting. Lastly, the Earth Class is the highest level, addressing the needs of students with severe conditions such as Down syndrome, severe cerebral palsy, and multiple disabilities. This class provides intensive support for children with the most complex learning and physical needs, ensuring they receive appropriate care and education in an adapted environment.

### **Earth Classroom**

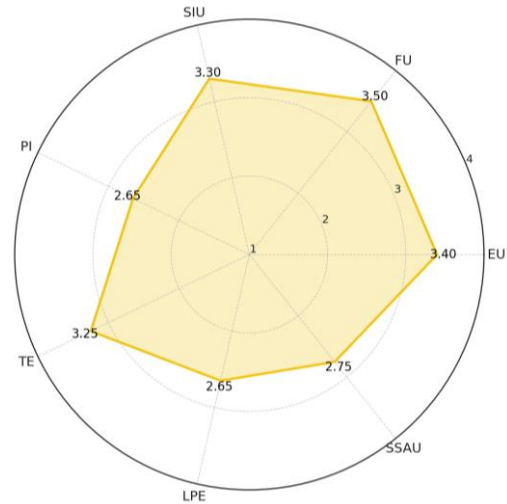
The Earth Classroom (Figure 3) recorded the lowest score among the four rooms (Figure 3), with several

aspects falling below 3.0, particularly Perceptible Information (2.65), Low Physical Effort (2.65), and Size and Space for Approach and Use (2.75). These results indicate that access to information, physical comfort, and mobility space remains limited. Observational findings support this conclusion, as visual media and areas for free activities were found to be insufficient.



**Figure 3. Earth Classroom**  
Source: Author's documentation, 2025

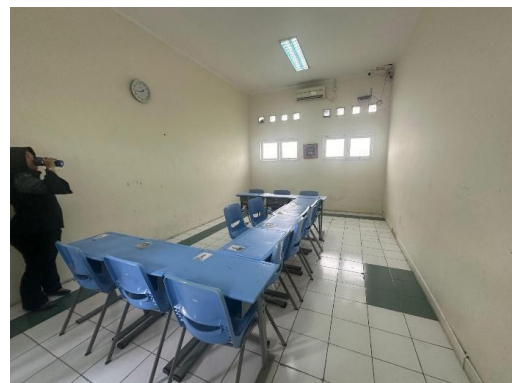
Nevertheless, this classroom demonstrated strength in Flexibility in Use (3.50), supporting variations in activities, particularly for students with higher levels of independence. The layout was relatively simple and intuitive for students with greater autonomy. The radar chart (Figure 4) illustrates an unbalanced profile, with certain aspects showing sharp declines compared to other classrooms. This emphasizes the need for significant improvements in the provision of information media, physical comfort, and mobility to ensure this classroom offers an equitable learning experience.



**Figure 4. Earth Classroom radar chart**  
Source: Author's work and analysis, 2025

### Venus Classroom

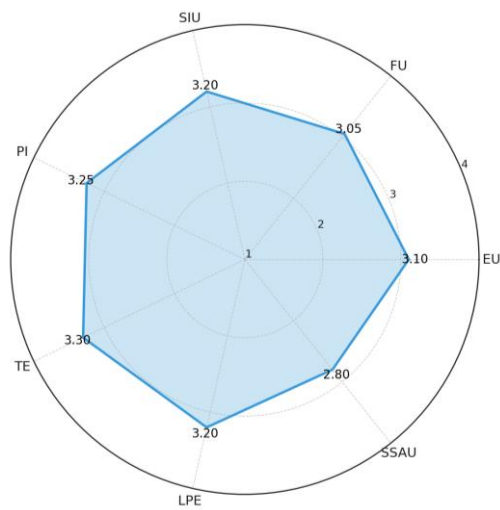
The Venus Classroom (Figure 5) recorded average scores ranging between 2.80 and 3.30, lower than those of the Sun and Mercury Classrooms. The strongest aspect was Tolerance for Error (3.30), reflecting attention to student safety through the use of secure and supportive learning aids. In contrast, the lowest score was observed in Size and Space for Approach and Use (2.80), indicating limited mobility space and the need for improved accessibility, particularly for wheelchair users.



**Figure 5. Venus Classroom**  
Source: Author's documentation, 2025

In terms of design, the Venus Classroom already supports

communication through assistive tools, a simple layout (Figure 5), and the provision of information through adequate visual media. Activities in this classroom generally require low physical effort, making it suitable for students with motor limitations. The radar chart (Figure 6) presents a relatively even profile, though without notable strengths, and a clear weakness in mobility. This finding highlights that the Venus Classroom requires additional interventions to better approximate an ideal inclusive learning environment.



**Figure 6. Venus Classroom radar chart**  
Source: Author's work and analysis, 2025

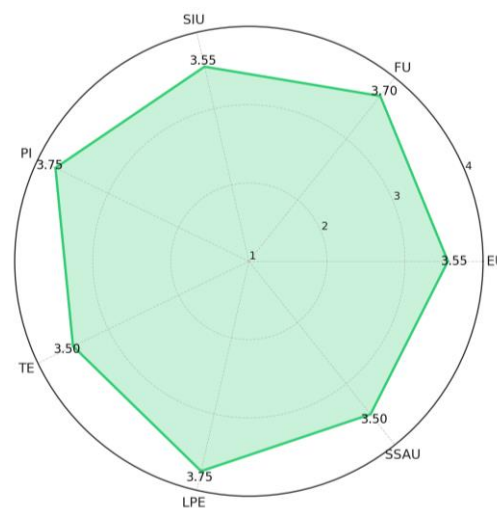
### Mercury Classroom

The Mercury Classroom ranked second (after the Sun Classroom), with consistent scores ranging between 3.50 and 3.75. The main strengths were observed in Perceptible Information (3.75) and Low Physical Effort (3.75), indicating that information delivery was sufficiently clear and that learning activities did not require excessive physical exertion. Observations also revealed the use of assistive tools tailored to students' needs, as well as safe furniture suitable for active children (Figure 7).



**Figure 7. Mercury Classroom**  
Source: Author's documentation, 2025

The weaknesses of the Mercury Classroom were relatively minor, limited primarily to the provision of additional visual media for students with cognitive impairments. Its layout flexibility was found to be better than that of other classrooms, and the spatial arrangement was intuitive across varying ability levels. The radar chart (Figure 8) shows an almost circular form, with consistently high scores across all aspects, reinforcing that this classroom strongly supports equal access and inclusive learning experiences.



**Figure 8. Mercury Classroom radar chart**  
Source: Author's work and analysis, 2025

### Sun Classroom

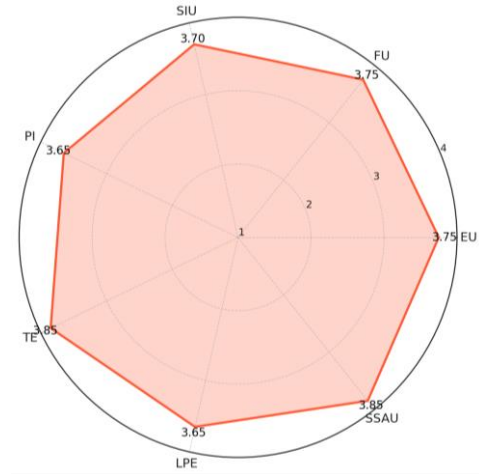
The Sun Classroom achieved the highest level of implementation of

Universal Design principles. The average scores for nearly all aspects were above 3.6, with the highest scores in Tolerance for Error and Size and Space for Approach and Use (3.85). These results are consistent with field observations, which showed that the room was equipped with child-friendly furniture and provided ample space to support free mobility (Figure 9). The classroom also succeeded in minimizing physical effort, making it comfortable for all students.



**Figure 9. Sun Classroom**  
Source: Author's documentation, 2025

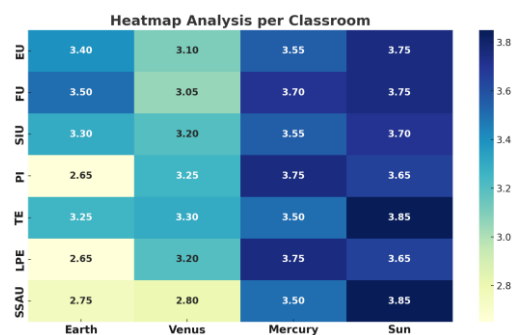
Nevertheless, certain critical points remain, particularly concerning the use of visual media. While the information provided was adequate, it requires reinforcement to be more inclusive for students with cognitive impairments. The classroom's simple layout could also be enhanced to be more intuitive by integrating additional learning media. The radar chart (Figure 10) illustrates a relatively balanced profile, with strengths concentrated in tolerance for error and mobility space, positioning the Sun classroom as the closest to the ideal standard.



**Figure 10. Sun Classroom radar chart**  
Source: Author's work and analysis, 2025

### Heatmap Analysis

The heatmap analysis, as shown in Figure 11, functions as an effective method for assessing Universal Design and can be considered a state-of-the-art (SOTA) approach for educational institutions serving students with disabilities. This visual approach is crucial, as it enables researchers and stakeholders to compare which spaces align with the seven principles of Universal Design and which do not. By applying this method to PSNC, the heatmap effectively visualizes the level of design implementation in each classroom, serving as a reference for future improvements. Consequently, enhancement efforts can be focused on classrooms with the lowest implementation scores.



**Figure 11. Heatmap analysis per classroom**  
Source: Author's analysis, 2025

The Sun Class is designated for students with mild conditions such as mild autism, Down syndrome, and ADHD. The classroom is therefore designed to meet their initial needs in a safe, simple environment. The Mercury Class accommodates students with autism, mild cerebral palsy, and learning difficulties, requiring a more structured yet still flexible spatial arrangement. The Venus Class focuses on students with moderate autism, moderate cerebral palsy, and general developmental disorders, necessitating additional support within a simple but accessible spatial layout. Finally, the Earth Class is reserved for children with the most severe conditions, such as severe Down syndrome, severe cerebral palsy, and multiple disabilities. This classroom requires the highest level of support, both physical and instructional.

Within this context, the heatmap shows that Equitable Use is more fully achieved in the Sun and Mercury classrooms, where spaces provide relatively equal user experiences for all students. In contrast, in the Venus and especially the Earth classrooms, this principle is less evident, indicating that access to facilities remains uneven. Flexibility in Use is also more prominent in the Sun and Mercury classrooms, where modular and adaptive furniture is present, whereas in Venus and Earth, it remains limited. Simple and Intuitive Use scores were high for Sun and Mercury but lower for Venus and Earth, highlighting the need for clearer layouts to better support students with more severe cognitive impairments.

The dimension of Perceptible Information displayed the most striking differences. Mercury excelled at delivering clear information supported by visual media, while Earth scored the

lowest, reflecting severe limitations in providing information to students with cognitive challenges. This situation underscores a critical issue in the classroom intended for students with the most complex needs. Tolerance for Error was relatively strong across all classrooms, with Sun achieving the highest score, indicating that safety considerations have been well integrated into the design. However, in Low Physical Effort and Size and Space for Approach and Use, Venus and Earth again recorded lower scores, pointing to limitations in ergonomics and mobility space. This is particularly problematic for students with motor impairments or those using wheelchairs, as they are the ones who require the greatest level of physical support.

## Conclusion

This study demonstrates that the implementation of Universal Design principles at the President Special Needs Center (PSNC) has begun to take shape, although the results remain uneven. The Sun and Mercury classrooms achieved high scores, particularly in Tolerance for Error, Flexibility in Use, and Perceptible Information. These results correspond to the profiles of students with mild-to-moderate conditions. The learning environments in these classrooms are relatively safe, intuitive, and flexible.

In contrast, the Venus and Earth classrooms recorded low scores in critical dimensions, especially Perceptible Information, Low Physical Effort, and Size and Space for Approach and Use. Limitations in facilities, ergonomics, and spatial circulation present challenges for students with more complex conditions.

The main contribution of this study is the provision of a systematic assessment

framework. The assessment method used has proven effective in mapping the extent of implementation. This method can be adopted by other educational institutions for students with disabilities as an evaluation guide to identify whether each classroom aligns with the principles of Universal Design. Furthermore, these findings serve as a practical guide for PSNC to conduct continuous assessments and implement design improvements, thereby achieving greater alignment with Universal Design and creating a truly inclusive learning environment for all students.

PSNC has made significant progress, yet improvements are needed to achieve more consistent implementation. Strengthening three key areas, namely information media, furniture ergonomics, and spatial accessibility, will contribute to a more inclusive environment. These improvements will support the broader goal of inclusive education and help position PSNC as one of the best practice models in Indonesia.

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