© Journal of Accessibility and Design for All (JACCES), Volume 16, Issue 2, 2026, ISSN: 2013-7087
DOI: https://doi.org/10.17411/jacces.v16i2.724

An examination of students' metaphorical perceptions of universal design across different faculties

Bridging disciplinary knowledge and inclusive practice.

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Received: 2026-02-03 | Accepted: 2026-06-23 | Publication: 2026-11-11

Abstract: This study investigated the metaphorical perceptions of universal design among students from different faculties. Using a descriptive qualitative research design, 202 students were asked to complete an open-ended prompt: "Universal design is like... because..." The generated metaphors were analysed using content and descriptive analysis techniques to identify underlying themes and their alignment with the seven core principles of universal design. The findings reveal that students' perceptions are predominantly concentrated under the "Equitable Use" principle, highlighting a strong association between universal design and social justice or inclusivity. However, significant disciplinary variations were observed, suggesting that students' professional backgrounds (e.g., architecture vs. education) influence their focus on physical versus pedagogical accessibility. The study concludes that while students possess a foundational understanding of universal design, there is a need for more interdisciplinary integration in higher education to bridge the gap between theoretical principles and practical application.

Keywords: universal design, metaphorical perceptions, inclusive education, accessibility, equity.

1. Introduction

In recent years, approaches aimed at increasing inclusivity in education have become more prominent. Universal design (UD) is notable for its objective to create learning environments that accommodate all individuals, regardless of physical, mental, or cultural differences. Rather than treating differences as barriers, UD utilizes them to enhance instruction and promote the development of accessible, flexible learning spaces (Pobiner, 2016). UD is designed to address increasing student diversity and transform both the physical and pedagogical dimensions of education (Garcia-Huidobro et al., 2017).

Originating in architecture in the 1980s with Ronald L. Mace, UD focused on making environments more accessible for people with disabilities. This focus broadened to include age, language, learning styles, and culture, making UD a foundation for broader inclusivity (Zeyrek-Çepehan & Güller, 2020). The seven principles defined by the Centre for Universal Design at North Carolina

State University (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) capture the breadth of UD.

The Universal Design for Learning (UDL) and Universal Design for Instruction (UDI) models, developed based on universal design principles in educational settings, increase teaching flexibility and support diverse methods and materials suitable for different learning styles (Levey, 2018; Reyes, Meneses, Melián &, 2022). However, the implementation of these models remains limited because of specific structural and pedagogical barriers. Teachers' lack of knowledge and skills on the subject, the inflexibility of the curriculum, the inability of assessment systems to reflect diversity, and the lack of administrative awareness constitute significant obstacles to their application (Power, 2000; Shi et al., 2023; Zallio & Clarkson, 2023). The education system's focus on the normative student profile leads to resistance to differences, making it challenging to promote an understanding of inclusive education (Yu et al., 2024).

To bridge the practical challenges with conceptual understanding, it is essential to consider the theoretical frameworks that underpin the implementation of UD. A comprehensive understanding of these challenges requires consideration of the theoretical frameworks and approaches that inform the implementation of UD in educational contexts. Social justice principles, for instance, underscore the importance of providing equal opportunities for all learners.

Philosophical frameworks, including critical pedagogy, further support the transformative objectives of UD and UDL within inclusive education. These perspectives contribute to a deeper understanding of the potential societal impact of universal design. An expanding body of research examines the advantages and limitations of implementing UD in educational practice, thereby identifying areas for further investigation and highlighting specific disciplinary gaps. Analysing individuals' perceptions of a multidimensional concept such as UD elucidates both its practical and conceptual significance. The integration of UD across diverse disciplines has not become merely a technical adoption but a conceptual shift that requires a transformation in practitioners' mental models (Jones, 2014; Rose, 2001). Since UD principles are often perceived through the lens of one's primary field of study, whether the spatial focus of architecture or the pedagogical focus of education, a standard survey might fail to capture the nuanced, often subconscious disciplinary biases (Moore, 2007). Conceptual Metaphor Theory provides the necessary theoretical bridge here, positing that metaphors are not merely figurative speech but reflect the underlying cognitive structures through which students internalize and reformulate the 'abstract' ideal of inclusivity into 'concrete' professional practice (Lakoff & Johnson, 1980; Littlemore, 2001). Metaphors serve as effective cognitive tools for interpreting abstract concepts, as conceptual metaphor theory suggests that individuals structure complex phenomena through metaphors grounded in concrete experiences (Lakoff & Johnson, 1980; Landau, Barrera, & Keefer, 2017; Stamenković, Ichien, & Holyoak, 2020). By connecting theoretical perspectives with students' perceptions, metaphor analysis offers a practical lens for understanding how these concepts are internalized and applied. Moving from theoretical considerations to practical application, investigating students' descriptions of universal design reveals both their personal interpretations and the social and pedagogical contexts in which the concept is situated (Saban, Koçbeker, & Saban, 2006).

Perceptions of abstract, multidimensional concepts, such as universal design, offer insight into how they are positioned in educational practices. The metaphors used to make sense of such concepts are powerful linguistic and cognitive tools (Smedinga, Cienki, & Regt, 2023). Metaphor

analysis, based on Lakoff and Johnson, allows examination of the ways thought is shaped through language (Jensen, 2006; Lakoff & Johnson, 1980; Schmitt, 2005), revealing conceptual frameworks in education, teaching, and technology (Saban, 2006; Bagrıacık-Yilmaz, 2019; Balıkçı, Hayoğlu, & Alpsülün, 2024). As Freire noted, hearing students' voices is vital for educational democratization, and their metaphors for universal design reflect their expectations for liberation and inclusivity (Freire, 2000).

Recent academic research suggests that Universal Design extends beyond physical accessibility. In the context of higher education, it has evolved into a comprehensive framework that embraces neurodiversity and digital environments (Fernando 2026; Sousa, & Harb 2025). Meta-analyses indicate that effectively applying the three fundamental principles of UDL, engagement, representation, and action and expression, has a significant impact on student engagement and academic success (Almeqdad et al., 2023). Studies examining the views of neurodivergent students have highlighted that these learners often face challenges with conventional teaching methods. However, they prefer anonymous and adaptable interaction methods provided by digital platforms such as Quizizz and Padlet, as these tools help reduce social pressure (Durgungoz & Durgungoz, 2025; Harrison et al., 2024). In this scenario, investigating students' metaphorical understanding of universal design is essential, not only for conceptual analysis but also for understanding how neurodivergent needs are integrated into increasingly digital educational environments (Vincent et al., 2025).

Despite the recognized value of this approach, limited research has investigated students' metaphorical perceptions of UD, particularly across different faculties. Examining these perceptions helps bridge the gap between disciplinary knowledge and the practical implementation of inclusive design principles. Analysing these perceptions clarifies how discipline-specific knowledge shapes students' understanding and internalization of universal design. The findings of this study offer both methodological and theoretical foundations for developing accessible and inclusive teaching approaches and for integrating universal design principles into educational policies (Walters, 2010; Hofman & Kilimo, 2014). University students conceptualize UD differently across faculties, and these perceptions reflect specific core principles of UD; analysing their metaphorical expressions can reveal how disciplinary knowledge shapes students' understanding and interpretation of inclusive design. This study, therefore, investigates the relationship between students' metaphorical expressions and the core principles of UD, examining how these perceptions vary across faculties. In doing so, the research provides a more apparent connection between the theoretical underpinnings of UD and students' practical conceptualizations, thereby strengthening the rationale for an interdisciplinary approach. Additionally, it sought to conduct an interdisciplinary assessment based on faculty differences. Accordingly, the study explored the relationship between the metaphors generated by students and the core principles of UD, specifically investigating which UD principles are represented in students' metaphors and how these metaphorical perceptions vary across faculties.

2. Methodology

This research was designed as a qualitative study employing a phenomenological approach to explore students' experiences and perceptions of UD. Data were collected through open-ended questions, enabling participants to articulate their understanding of the concept. Participants conveyed their perceptions of universal design by generating written metaphors and providing explanatory rationales for their metaphorical expressions. The study was grounded in a phenomenological approach and informed by the principles of naturalistic inquiry (Blumer, as

interpreted by Athens, 2010), which emphasizes studying social phenomena in their natural context and allowing meanings to emerge inductively from participants' own interpretations.

2.1. Participants

The research involved students aged 18 and older from various faculties at Bolu Abant İzzet Baysal University, located in north western Türkiye between Ankara, the capital city, and Istanbul, the country's leading commercial and industrial centre. Situated between these two major cities, one in Central Anatolia and the other in the Marmara Region, the university occupies a geographically significant position that facilitates access for students from diverse regions. The institution admits students from across Türkiye and abroad, contributing to the diversity and inclusiveness of the student body. Participants were selected purposively, and data collection was voluntary. The demographic characteristics of the participants are presented in Table 1.

Prior to data collection, all participants were briefed on the study's objectives and the voluntary nature of their involvement. Informed verbal consent was obtained from all participants, ensuring they understood that their responses would remain anonymous and be used strictly for academic research purposes.

Table 1. Demographic characteristics of the participants

Variable	Category	n
Gender	Male	92
Gender	Female	110
Age	17-26	196
Age	27-36	2
Age	37-46	2
Age	47-50	2
Grade	First grade	59
Grade	Second grade	51
Grade	Third grade	45
Grade	Fourth grade	47
Faculty	Faculty of Theology	35
Faculty	Faculty of Communication	17
Faculty	Faculty of Science and Letters	26
Faculty	Faculty of Fine Arts	9
Faculty	Faculty of Architecture	23
Faculty	Faculty of Tourism	14
Faculty	Faculty of Engineering	26
Faculty	Faculty of Sports Sciences	25
Faculty	Faculty of Education	27

Two hundred two university students took part in the study. Among the participants, 110 were female, and 92 were male. The age distribution indicates that the overwhelming majority, 196 students, fall within the 17-26 age range. The breakdown by academic year shows 59 first-year students, 51 second-year students, 45 third-year students, and 47 fourth-year students. Participants are enrolled in various faculties, with the Faculty of Theology having the highest representation at 35 students. This is followed by the Faculty of Education, with 27 students, and both the Faculty of Engineering and the Faculty of Science and Letters, each with 26 students.

2.2. Data collection tool

Based on a comprehensive review of the relevant literature (Schmitt, 2005; Tannehill & MacPhail, 2012), the researchers determined that open-ended prompts of the form *"X is like … Because …"* are effective for eliciting participants' conceptual understandings through metaphorical expressions. The literature also emphasizes the importance of collecting demographic information and suggests that thematic content analysis is a suitable approach for analysing metaphor data. These insights informed the development of the data collection instrument used in this study.

2.3. Data collection procedure

The data were collected during the spring semester of the 2024–2025 academic year. Participants were asked to complete the open-ended prompt *"Universal Design is like … because …"* in a written form during class time. The instructions emphasized that there were no right or wrong answers and that students should express their own perceptions freely. Each response was coded anonymously to ensure confidentiality. The collected data were then compiled and prepared for qualitative analysis.

2.4. Data Analysis

The qualitative data obtained in this study were analysed manually using a thematic analysis approach. In line with the principles of naturalistic inquiry (Lincoln & Guba, 1985), the metaphorical expressions produced by the students were carefully examined, meaning units were identified, and each metaphor was interpreted within the framework of Universal Design principles. To ensure methodological rigour, the analysis followed a systematic process: (1) all 202 metaphorical expressions and their rationales were organized; (2) each metaphor was reviewed alongside its student-provided explanation to capture its true intent; (3) metaphors were cross-referenced with the operational definitions of the seven core principles of UD; and (4) researchers engaged in independent coding followed by consensus building to resolve any thematic ambiguities. The metaphors were categorized according to the seven core principles of Universal Design: Equitable and Fair Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, and Appropriate Size and Access Space. Each metaphor was associated with the relevant principle(s), and metaphors reflecting similar themes were grouped. It is important to note that a fully inclusive approach was adopted, and no metaphors were excluded from the analysis to ensure that the diversity of all participants' voices was preserved. During this grouping process, the conceptual associations, verbal analogies, and metaphorical structures contained in the metaphors were evaluated collectively. Based on these groups, overarching themes were generated and interpreted. In this way, the students' mental representations of Universal Design and the meanings they attributed to the concept were systematically analysed and interpreted in accordance with qualitative data analysis principles

and naturalistic inquiry methodology. In line with Athens' (2010) interpretation of Blumer's framework, the data analysis followed the logic of naturalistic inquiry, consisting of three interrelated phases: exploration, inspection, and confirmation. The process concluded with the validation and refinement of themes through iterative reflection and discussion among the researchers, ensuring that the final thematic framework accurately represented participants' perspectives. To maintain full transparency and allow for independent verification, a comprehensive inventory of all metaphors is provided in the Appendices (Appendix 1 and 2), and the complete dataset supporting this research is publicly available in the Mendeley Data repository (Sivrikaya et al., 2025).

2.5. Reliability

To ensure inter-coder consistency in the study, coding reliability data were calculated. Coding reliability was determined by dividing the number of agreements between the two coders by the total possible number of agreements for the codes and then multiplying by 100 (Miles & Huberman, 1994). The inter-coder reliability was initially calculated at 94.5%, indicating agreement on 191 of 202 metaphors. For the remaining 11 metaphors with discrepancies (e.g., mother, scales, library, escalator), the researchers held a consensus-building session. During this session, the participants' written rationales for these specific metaphors were re-examined in detail to align the coding with the students' original intent. Through this iterative discussion, a 100% final consensus was reached on the categorisation of all metaphors. Furthermore, the Cohen's Kappa coefficient was calculated using the formula $K = \frac{P_o - P_e}{1 - P_e}$ (Cohen, 1960). The observed agreement (Po) was 0.945 and the probability of chance agreement (Pe) was 0.29 based on the marginal frequency distributions of the categories. The resulting Kappa value of 0.92 indicates an 'almost perfect agreement' according to the criteria established by Landis and Koch (1977), confirming the high objectivity and reproducibility of the categorical analysis. Having coding reliability above 90% is considered an accepted criterion (Saldana, 2015). In addition to inter-coder reliability, the overall trustworthiness of the qualitative findings was ensured through several strategies consistent with the principles of naturalistic inquiry (Lincoln & Guba, 1985; Athens, 2010). Credibility was enhanced through iterative reading and interpretation of the metaphors until conceptual saturation was achieved, while transferability was supported by providing detailed contextual information about the participants and the study setting. Dependability was ensured by maintaining an audit trail of analytical decisions and coding procedures, and confirmability was achieved by comparing and verifying the thematic structure between coders to ensure that interpretations were grounded in participants' actual expressions rather than researcher bias.

3. Findings

3.1. Findings on the relationship between students' metaphors and universal design principles

The students created 202 metaphors about universal design. Considering the metaphors and their justifications specified by the students, the metaphors were ranked from highest to lowest frequency and grouped into seven categories: "Equitable Use" (95 metaphors), "Perceptible Information" (39 metaphors), "Size and Space for Approach and Use" (25 metaphors), "Flexibility in Use" (25 metaphors), "Low Physical Effort" (7 metaphors), "Tolerance for Error" (8 metaphors),

and “Simple and Intuitive Use” (3 metaphors). When the categories are examined according to their constituent codes, the “Equitable Use” category is comprised of the codes universality/integrity/inclusivity, equality and fairness, balance/order, similarity and, sensitivity; the “Perceptible Information” category consists of the codes need, guide, reflectivity/expression, clarity, valuable, transparency, empathy, and hope; the “Size and Space for Approach and Use” category is made up of the codes infinity, accessibility, ideal and, existence/nonexistence; the “Flexibility in Use” category includes the codes diversity/relativity, individuality, difference, live-dynamic, imagination, complexity, and utopian; the “Low Physical Effort” category consists of the codes ease and happiness/well-being; the “Tolerance for Error” category includes the codes development-process and precaution; and the “Simple And Intuitive Use” category is comprised of the codes flexibility and simplicity. The analysis revealed 30 codes under the universal design principles. A comprehensive list of all metaphors associated with these codes and categories is provided in Appendix 1.

3.2. Findings on students’ metaphorical perceptions of universal design principles across faculties

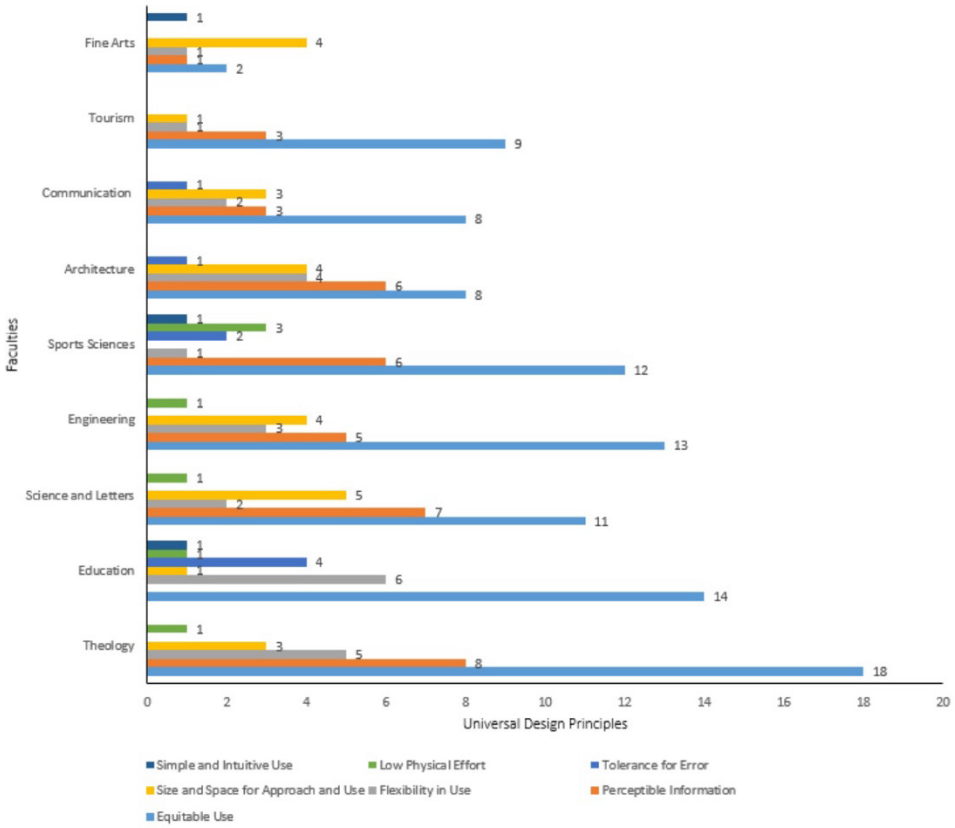
The metaphorical perceptions of students regarding UD principles were first analysed quantitatively to determine the distribution of themes across different academic disciplines. This comparative overview allows for a broader understanding of how various faculties prioritize different aspects of accessibility and design. Table 2 summarizes the frequency of metaphors produced by students from nine different faculties, categorized according to the seven fundamental principles of universal design.

As shown in Table 2, while "Equitable Use" emerged as the most frequently metaphorized principle across nearly all disciplines, significant variation was observed in other categories, such as "Perceptible Information" and "Flexibility in Use".

Table 2. Distribution of students’ metaphorical perceptions across faculties and universal design principles

Faculties	Equitable Use	Perceptible Information	Flexibility in Use	Size and Space for Approach and Use	Tolerance for Error	Low Physical Effort	Simple and Intuitive Use
Theology	18	8	5	3	0	1	0
Education	14	0	6	1	4	1	1
Science and Letters	11	7	2	5	0	1	0
Engineering	13	5	3	4	0	1	0
Sports Sciences	12	6	1	0	2	3	1
Architecture	8	6	4	4	1	0	0
Communication	8	3	2	3	1	0	0
Tourism	9	3	1	1	0	0	0
Fine Arts	2	1	1	4	0	0	1

Figure 1. Distribution of Universal Design Principles across faculties



As illustrated in Figure 1, a comparative analysis of metaphorical perceptions reveals that the principle of Equitable Use serves as a common conceptual core across all faculties, reaching its peak frequency in Theology (n=18) and Education (n=14). However, the graphical representation highlights significant disciplinary nuances: for instance, while Education students emphasize Tolerance for Error (n=4), students from Fine Arts and Science and Letters focus more on Size and Space for Approach and Use (n=4 and n=5, respectively). Conversely, principles such as Low Physical Effort and Simple and Intuitive Use exhibit the lowest frequencies across the board, suggesting a conceptual gap in these functional dimensions of Universal Design, regardless of students' academic background.

In addition to the numerical distribution in Table 2, a comparative word cloud analysis (see Figure 1) provides a qualitative synthesis of the metaphorical landscape across faculties. This visualization reveals distinct disciplinary leanings: while Theology and Education students gravitate towards metaphors of 'balance' and 'inclusion' (e.g., scales, puzzle), Architecture and Fine Arts students employ more spatial and structural metaphors (e.g., ocean, earth, buildings), reflecting a design-oriented perspective. The dominance of 'Equitable Use' is visually evident across all clouds, yet the secondary themes, such as 'Perceptible Information' in Engineering and 'Equitable Use' in Science and Letter, highlight how academic background nuances the conceptualization of Universal Design. This visual synthesis confirms that students do not perceive UD merely as a set of rules but as a diverse conceptual framework shaped by their specific fields of study.

To provide a more nuanced understanding of these perceptions, the qualitative data for each faculty, including specific metaphors and sample expressions, are detailed in the following subsections. Furthermore, Appendix 2 provides a comprehensive inventory listing all students' metaphors, their associated UD principles, and corresponding sample expressions.

Figure 2. Comparative Word Cloud Visualization of Metaphorical Perceptions across Different Faculties



The analysis of metaphors generated by students from different faculties demonstrates that UD is predominantly understood as a concept grounded in justice, inclusivity, and accessibility, though its interpretation varies across disciplinary perspectives. Across all faculties, the principle of Equitable Use emerged as the most frequently emphasized category, indicating a shared ethical core in students' conceptualizations of UD. Students consistently associated universal design with fairness, equality, and social harmony; however, the metaphors they employed revealed differences in the depth, focus, and functional orientation of this understanding (see Figure 2).

Faculties such as Theology, Education, Communication, Tourism, and Science and Letters framed universal design primarily within ethical, social, and philosophical dimensions. Theology students conceptualized UD through metaphors reflecting balance, divine order, and moral responsibility, positioning design as an extension of spiritual and social justice. Similarly, Education students emphasized inclusivity and equality, interpreting UD as a pedagogical tool that embraces all learners and sustains hope and continuity within inclusive education. Communication students extended this ethical framing by highlighting not only physical but also emotional and cognitive accessibility, portraying UD as a humanistic structure grounded in empathy and order. Tourism and Science and Letters students reinforced this perspective through metaphors of transparency, reflection, existence, and nonexistence, suggesting that UD is perceived as both a mirror of society and a fundamental requirement of human life. Collectively, these faculties approached universal design as a value-based construct, closely linked to social responsibility, moral awareness, and philosophical reflection.

In contrast, students from Engineering, Sports Sciences, Architecture, and Fine Arts placed greater emphasis on the functional, spatial, and aesthetic dimensions of universal design, while still grounding their interpretations in equitable use. Sports Sciences students predominantly evaluated UD on practicality, ease of use, and daily functionality, using concrete metaphors related to basic needs and physical accessibility. Engineering students, although expected to focus on technical aspects, instead favoured abstract and socially resonant metaphors, underscoring comprehensibility, shared values, and access to information rather than purely mechanical solutions. Architecture students demonstrated the most multidimensional

engagement with UD principles, integrating equity with flexibility, spatial accessibility, sustainability, and sensory–aesthetic considerations, reflecting a design-orientated and creative perspective. Fine Arts students uniquely prioritized the principle of Size and Space for Approach and Use, conceptualizing UD as limitless, accessible, and meaning-oriented through expansive and aesthetic metaphors such as the world, ocean, and art.

Despite these variations, certain principles, particularly Low Physical Effort and Tolerance for Error, were weakly represented across faculties. While some metaphors indicated partial awareness of sustainability, durability, and resilience, the limited number and depth of these metaphors suggest gaps in students' conceptual understanding of UD's functional dimensions. Overall, the findings indicate that although students share a strong ethical perception of universal design centred on justice and inclusivity, their understanding of its technical, functional, and error-tolerant aspects remains uneven and discipline-dependent.

4. Result

The analysis of 202 metaphors revealed that students' perceptions of universal design are predominantly organised around a limited number of core principles. Across all faculties, Equitable Use emerged as the most frequently represented principle, indicating a shared emphasis on justice, equality, and inclusivity in students' conceptualisations of universal design. This principle was consistently prioritised across disciplinary backgrounds.

Other principles, including Perceptible Information, Size and Space for Approach and Use, and Flexibility in Use, were represented at moderate levels and showed greater variation across faculties. These principles reflected differences in how students emphasised cognitive accessibility, spatial considerations, adaptability, and diversity across academic disciplines.

In contrast, the principles of Low Physical Effort, Tolerance for Error, and Simple and Intuitive Use were weakly represented in the metaphors generated by students from all faculties. These principles accounted for the lowest frequencies overall, indicating limited metaphorical engagement with the functional and error-related aspects of universal design.

Overall, the results show that while students across faculties share a strong orientation toward the ethical and social dimensions of universal design, the distribution of metaphors across principles varies by discipline, with some principles receiving consistently less attention than others.

5. Discussion

This study examined university students' metaphorical perceptions of UD across different faculties and found that students emphasized themes of justice, inclusivity, accessibility, and social equality. The findings both align with and diverge from the existing literature, enabling a multi-layered understanding of how students from various disciplines conceptualize UD.

The prominence of the "Equitable Use" category across all faculties indicates that students interpret UD within the axes of justice, equality, and inclusiveness. This finding reflects not only students' inherent valuation of fairness and accessibility but also aligns with theoretical frameworks emphasizing social justice and democratic participation in education (Nussbaum, 2011; Freire, 2000). By situating UD in the context of equity, the results suggest that students internalize broader societal and ethical dimensions of design, highlighting the importance of incorporating social justice considerations into both pedagogy and institutional policy.

Furthermore, this emphasis underscores that curriculum designers and educators can leverage students' perceptions to prioritize inclusivity and equitable access, ensuring that learning environments actively reflect these principles. This also has practical implications for teacher training programs, where modules can explicitly address inclusive and equitable design, guiding instructors to implement strategies that respond to the needs of diverse learners. This finding aligns with studies that define UD as a structure that serves social equality, democratic participation, and social justice (Zallio & Clarkson, 2023; Tang et al., 2022; Nussbaum, 2011). Zallio and Clarkson emphasized that inclusive and accessible design is a fundamental condition of UD, which aligns with the frequent emphasis on social justice in students' metaphors. In students' metaphorical expressions, social values also point to the ethical and philosophical dimensions of UD (Rawls, 1999; Freire, 2000). However, these emphases diverge from those in the study by Khalil, Ramzy, and Mostafa (2013), which addressed sustainability and equity-based design. Because Khalil et al.'s (2013) study did not directly focus on social justice or inclusion, only a limited connection can be made with the current study. This contrast highlights how students' metaphorical perceptions extend traditional UD frameworks by incorporating ethical, social, and philosophical dimensions that may not be emphasised in conventional design studies.

In particular, the evaluation of UD by students from the Faculty of Education and the Faculty of Arts and Sciences in terms of cognitive and emotional accessibility highlighted the importance of the "Perceptible Information" category. This suggests that UD is perceived not only as a physical design principle but also as a pedagogical approach that values cognitive inclusivity and equitable access in learning. By linking perceptible information to educational practice, this finding highlights that UD principles can inform curriculum design, instructional strategies, and learning technologies to support the needs of diverse learners (Dolmage, 2017; Meyer et al., 2014). Research, such as that by Super et al. (2020), suggests that UD has the potential to transform learning processes and highlights the importance of designs that cater to students' individual learning needs. In this context, students' metaphors align with the fundamental principles of the Universal Design for Learning (UDL) and Universal Design for Instruction (UDI) models (Levey, 2018; Reyes et al., 2022). However, factors such as teachers' lack of knowledge, rigid curricula, and administrative barriers pose severe limitations to the implementation of these models (Shi et al., 2023; Power, 2000). Thus, while students perceive UD positively, systemic and structural barriers continue to hinder its practical application, underscoring the need for policy-level and institutional support to fully realise its potential (Yu et al., 2024).

The metaphorical insights uncovered in this study reveal notable similarities with current debates in the literature concerning neurodiversity and digital accessibility. For instance, students' metaphors describing universal design as a 'liberating tool' or a 'supportive ecosystem' resonate with the aims of diminishing stigma and enhancing self-advocacy skills, as highlighted by Schuck and Fung (2024). According to Harrison et al. (2024), digital technologies are increasingly viewed not only as assistive resources but also as inclusive 'living spaces' that cater to the cognitive and emotional needs of neurodivergent students. However, as Karisa (2023) critically points out, the effectiveness of UDL strategies should extend beyond mere technical execution. As emphasized by Cole et al. (2024), it is crucial to consider the distinct needs of each student, especially neurodivergent individuals, when balancing flexibility with structured support in metaphorical reflection. Therefore, the differing perceptions across faculties confirm that universal design requires not only technical curriculum adjustments but also a comprehensive mind-set shift rooted in social justice (Espada-Chavarria et al., 2023; Priyadharsini & Sahaya-Mary, 2024).

One of the study's significant contributions is demonstrating how students perceive UD differently across disciplines. While architecture students tend to focus more on the aesthetic

and sensory aspects of design, engineering students emphasise the social functions and impacts of design. This disciplinary difference reveals that cognitive frameworks, epistemological foundations, and prior knowledge shape how students internalise multidimensional concepts like UD (Parpala et al., 2010; Singer & Smith, 2013). Understanding these differences can inform context-specific pedagogical interventions and curriculum development that align with disciplinary perspectives. In the study conducted by Wang et al. (2022), although the socio-political context of design in architectural education is highlighted, it does not directly overlap with the current research in terms of metaphorical analysis. Nevertheless, by offering a new perspective on students' interpretive practices, this study demonstrates the importance of metaphor analysis for understanding discipline-based differences in meaning-making. In this context, interdisciplinary perspectives contribute to a more comprehensive understanding of the pedagogical, social, and epistemological dimensions of UD (Lahti, 2023).

The relatively limited number of metaphors related to "Low Physical Effort" and "Tolerance for Error" suggests that students perceive these principles as secondary compared to other UD dimensions. Although the metaphors in these categories point to concepts such as sustainability, resilience, and functionality, which align with UD's understanding of long-lasting and effective design (Zallio & Clarkson, 2023; Tang et al., 2022), their overall scarcity suggests limited engagement with these functional aspects. This imbalance suggests that students may predominantly associate universal design with its ethical and social dimensions, such as equity and inclusion, while overlooking its functional and usability-related aspects. One possible explanation for this pattern is that universal design is often introduced in educational contexts primarily through the lens of accessibility and social justice, with less emphasis on technical principles related to usability, error tolerance, and efficiency (Nussbaum, 2011; Freire, 2000; Zallio & Clarkson, 2023; Tang et al., 2022).

In addition, these underrepresented principles may be less cognitively salient for students, as they require more concrete design experience and practical engagement to be fully understood. Unlike concepts such as fairness or inclusivity, which are socially visible and easily metaphorized, principles like "Tolerance for Error" or "Simple and Intuitive Use" are more abstract and embedded in design processes, making them less accessible for metaphorical thinking (Lakoff & Johnson, 1980; Landau et al., 2017; Stamenković et al., 2020). From a critical perspective, this finding may also indicate a gap in how universal design is taught across disciplines. The limited awareness of these principles suggests that current instructional approaches may not sufficiently address the full spectrum of UD, particularly its functional and user-experience dimensions (Meyer et al., 2014; Levey, 2018; Reyes et al., 2022; Shi et al., 2023). Therefore, a more balanced and comprehensive integration of all UD principles into higher education curricula is necessary to ensure that students develop a holistic understanding of UD.

The metaphor analysis method employed in this study provided detailed insights into how students make sense of UD, a concept that is abstract and multidimensional (Landau et al., 2017; Stamenković et al., 2020). By employing Lakoff and Johnson's (1980) conceptual metaphor theory, the study not only identified thematic patterns but also illuminated the cognitive and ethical dimensions embedded in students' interpretations. This method illustrates how metaphors serve as cognitive scaffolds, connecting abstract design principles to students' lived experiences and societal values (Saban, 2006; Jensen, 2006; Schmitt, 2005). Metaphors have been considered not only linguistic tools but also cognitive structures that shape individuals' conceptual worlds.

Beyond the cognitive structures identified by Lakoff and Johnson (1980), these metaphors must be interpreted within the context of modern Accessibility Theory. As Stevens (2019) articulates in the context of Hamraie's work, UD is not merely a neutral technical standard but a 'normative' project that shapes how future professionals perceive human variation and political belonging. In this study, metaphors that frame UD as a 'key' offer a dualistic interpretation. While a key suggests a facilitator role by providing a tool for entry, it simultaneously reflects what Hamraie calls 'access, knowledge', a conceptual framework that questions who holds the power to grant, possess, or restrict access.

Furthermore, as Titchkosky (2011) argues, when access is conceptualized only as a 'special' solution, much like a special key issued for a specific, segregated door, to accommodate a 'problematic body,' it creates a version of personhood that remains fundamentally excluded from the norm. This literal and symbolic reliance on 'special' access tools reinforces segregation rather than true inclusion. Such a perspective may hinder the broader implementation of UD by reducing it to a reactive, checklist-based adjustment or a secondary provision, rather than a proactive and universal design philosophy. Therefore, the disciplinary metaphors found in this research reveal the invisible 'epistemic' boundaries, the limits of what is known and practiced, that future practitioners may face. Bridging these metaphors with a critical disability perspective suggests that unless students' mental models shift from 'functional accommodation' to 'social justice' and symbolic belonging (Guffey, 2018), the actual implementation of UD will remain limited to physical compliance rather than holistic, meaningful inclusion.

The findings indicate that students assess UD not only in physical terms but also within cognitive, emotional, and social contexts. The prominence of justice and accessibility themes as common ground demonstrates that students recognise the ethical and pedagogical dimensions of UD, highlighting its relevance beyond mere technical design. By connecting UD principles to social justice and equity, students' perceptions provide actionable insights for curriculum development, instructional design, and policy formulation (Dolmage, 2017; Meyer et al., 2014; Nussbaum, 2011). However, the differences observed across disciplines indicate that UD education should be designed in a context-specific, discipline-sensitive manner. Instructors' interpretation of UD, aligned with their own disciplines' epistemological foundations, directly influences students' understanding (Parpala et al., 2010; Singer & Smith, 2013; Lahti, 2023). Future research should investigate how students' metaphorical perceptions of UD evolve and how these perceptions are reflected in their professional practices. In addition, analysing faculty members, administrators, and policymakers' metaphorical understanding of UD would be valuable for revealing how the concept is perceived at the institutional level. In conclusion, approaching UD as a concept of justice and access that encompasses not only individuals with disabilities but all individuals strengthen the inclusive and equitable nature of education, bridging theoretical understanding with practical application (Freire, 2000; Nussbaum, 2011; Rawls, 1999).

6. Limitations and Recommendations

The research was conducted only with university students from specific faculties and age groups, and the findings cannot be generalized to individuals of other ages or educational levels. Data were collected solely through open-ended questions; it is recommended that different methods be used for more in-depth analyses. Since the research was limited to a single university, cultural and regional differences were not taken into account. Although the study involved a significant sample of 202 students from various academic backgrounds, the distribution across faculties was not perfectly equal. Specifically, students from the Faculty of Theology (n=35), followed by the

Faculties of Education (n=27), Science and Letters (n=26), and Engineering (n=26), showed higher participation rates than those in other disciplines. This relative over-representation of certain academic fields may influence the overall metaphorical perceptions of universal design, as students' conceptualizations are often shaped by their specific disciplinary cultures. For future studies, it is recommended that more data be collected from individuals of different age groups, educational levels, and cultural backgrounds. Additionally, by ensuring a more balanced distribution of participants among faculties, metaphorical perceptions can be examined more comprehensively. For more in-depth analyses, data collection methods such as group work and focus group interviews should be employed. Ultimately, it is recommended that universal design be integrated into educational curricula to improve its effective implementation.

7. Conclusion

This study provides a comprehensive insight into how university students from different faculties conceptualize universal design through metaphors, revealing that UD is predominantly perceived as a framework grounded in justice, inclusivity, and accessibility. The findings demonstrate that, while students share a common ethical orientation toward equitable use, their metaphorical interpretations vary according to disciplinary perspectives, highlighting differences in emphasis on the cognitive, functional, spatial, and aesthetic dimensions of design. By employing metaphor analysis, the study contributes to the literature by illuminating the cognitive and value-based structures underlying students' understandings of UD, moving beyond purely technical interpretations. Overall, the results suggest that universal design is not merely a design principle but a multidimensional concept intertwined with social responsibility, educational equity, and human-centred values, underscoring the importance of discipline-sensitive, holistic approaches to UD education in higher education contexts.

To address areas of limited student awareness regarding certain UD principles, higher education curriculum designers should consider a more balanced integration of all UD dimensions. Courses could incorporate practical, hands-on design experiences that emphasize functional usability, error tolerance, and efficiency, alongside the more commonly taught ethical and social aspects, such as equity and inclusivity. Interdisciplinary collaboration across faculties can help students, link abstract UD concepts to concrete applications, while reflective activities, such as metaphor creation, case analyses, and design critiques, may strengthen students' understanding of less visible principles. By systematically embedding both technical and social-ethical aspects of universal design throughout curricula, universities can ensure that graduates develop a holistic understanding of UD, preparing them to create inclusive, effective, and human-centred designs in diverse professional contexts.

8. Acknowledgments

The authors thank all participants for their valuable contributions to this study.

AI Disclosure. The authors used AI-based tools to enhance the quality and rigor of this study. Scite.ai was used to support the literature review process by validating research citations. Additionally, Grammarly and Paperpal were utilized for language editing, proofreading, and improving the structural clarity of the English text. These tools were used solely for technical and linguistic support; the final manuscript was reviewed and approved by all authors, who remain fully responsible for the integrity and originality of the content.

Data availability statement. The dataset supporting this study is publicly available in Mendeley Data (*Sivrikaya et al., 2025).*

Ethics Statement. This research has been approved for ethical compliance by the Social Sciences Human Research Ethics Committee of Bolu Abant İzzet Baysal University with the decision dated 21.01.2025 and numbered 2025/01 (Protocol No.: 2025/05). Oral consent was obtained from the participants before the start of the research.

Conference presentation note. This study was presented as an oral presentation at the 14th National Special Education Student Congress, held at Bolu Abant İzzet Baysal University in Bolu on May 2–4, 2025.

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Appendix 1. A qualitative comparison between students' metaphors for universal design and its principles

Table a1.1. A qualitative comparison between students' metaphors for universal design and its principles

Category		Code	Metaphors	Sample Expression
Equitable (95)	Use	Universality/ integrity/ inclusivity (43)	Tree (1), Mother (1), Escalator (1), Connecting (1), Simple and Intuitive Use (1), White (1), A Whole (1), A Kind of Object That Makes Our Lives Easier (1), Integrative Perspective (1), Nature (2), World (1), A Newborn Baby (1), A Puzzle Where Different Pieces Can Come Together (1), Sky and Sea (1), Everyone (1), Equality (1), A Book Everyone Should Read (1), Feelings (1), Illusion (1), Door (1), Common Language (1), Kebab (1), Book (1), Sphere (1), Mevlana (1), Meeting Needs (1), Clean Air (1), Pomegranate (1), River (1), Freedom (1), Statue of Liberty (1), Sharing (1), Respect (2), Social Media (1), Like a Mirror Held Up to Society (1), Puzzle (3), Puzzle Pieces (1), Creative Way of Thinking (1), Round Shape (1)	"It is like a puzzle. Because when the pieces come together, they form a meaningful whole." (S2)
Equitable (95)	Use	Being equal and fair (41)	Water (2), Scales (3), Escalator (1), Religion of Islam (1), Justice (1), Truthfulness (1), Living According to Religion (1), Cloud (1), Equality (1), Face (1), Equality and Design (1), A Dream That Must Come True (1), Paint Palette (1), Access (1), A Free Country (1), Equality (1), Life (1), Structures Dependent on Imagination (1), Wholeness (1), Equal Use and Flexibility (1), A Society Where Everyone is Equal (1), A World Where Everyone is Loved (1), Designing According to Everyone's Situation (1), Being Unique (1), Sky (1), Appealing to All Segments of Society (1), Gender Equality (1), Something That Should Be (1), Scales of Justice (2), School (1), Childhood (1), Oxygen (1), To Live (1), An Equal Environment (1), Water Accessible to All (1), Still Water (1), Tree Roots (1)	"It is like a scale. Because equality is its goal." (S44)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Equitable Use (95)	Balance/ order (9)	Scales (2), Religion (1), Life (1), Justice (1), Order Itself (1), Order within Chaos (1), Laws of Life (1), Chain Links (1)	"It is like order within chaos. Because reflecting the styles of people living in different geographies under a single roof in the world population demonstrates order amid chaos." (S81)
Equitable Use (95)	Similarity (1)	Emotions (1)	"It is like emotions. Because everyone feels similar things." (S150)
Equitable Use (95)	Sensitivity (1)	The Embodiment of Understanding (1)	"It is like the embodiment of understanding. Because it advises us to be more sensitive towards people." (S125)
Perceptible Information (39)	Need (16)	Tree (1), Water (3), House (2), Nature (1), Bread (1), A Rare Plant (1), Education (1), Breathing (1), Shelter (1), Emotions and Senses (1), Being Able to Eat (1), Car (1), Oxygen (1)	"It is like house. Because everyone needs shelter." (S71)
Perceptible Information (39)	Guide (11)	Mind (1), Library (1), Sun (2), Star (1), Being a Muezzin (1), A Free Bird (1), Audible Pedestrian Crossing (1), Guide (1), Key (2)	"It is like the sun. Because it sheds light on every subject." (S107)
Perceptible Information (39)	Reflectivity/ expression (5)	Tree (1), World of Imagination (1), Free Mindset (1), Imaginary Buildings (1), Mirror (1)	"It is like imaginary buildings. Because design is the reflection of what we have in mind. (S108)
Perceptible Information (39)	Clarity (3)	The Things We See When We Look Back (1), The Embodied Form of the Soul (1), Common Language (1)	"It is like a common language. Because it is understood in conversations." (S96)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Perceptible Information (39)	Valuable (2)	Treasure (1), Jewel (1)	“It is like a treasure. Because it is very valuable for humanity.” (S127)
Perceptible Information (39)	Transparency (2)	Water (1), Transparency (1)	“It is like transparency. Because inside and out it is the same.” (S112)
Size and Space for Approach and Use (25)	Infinity (10)	Sea (1), Space (2), Earth (1), Drowning in the Ocean (1), Ocean (2), Sky (3)	“It is like sea. Because it is endless.” (S1)
Size and Space for Approach and Use (25)	Accessibility (8)	Water (1), Information (1), Easy, Comfortable, Straight Path (1), Art (1), Easy Trends and Paths (1), Perceptible Information (1), World of Software (1), Accessibility for Everyone (1)	“It is like information. Because everyone can easily benefit from it.” (S31)
Size and Space for Approach and Use (25)	Ideal (4)	An Unknown Utopia (1), Keeping Imagination Alive (1), The Eye Opening to Reality (1), The Need for Nutrition (1)	“It is like an unknown utopia, because people believe in what they don't know.” (S9)
Size and Space for Approach and Use (25)	Existence/ nonexistence (3)	Nature (1), Extinction (1), Each Person's Private World (1)	“It is like nature. Because existence is fundamental to every individual. Nature is a unique part of it.” (S60)
Flexibility in use (25)	Diversity/ relativity (9)	It is a Confusion Where Everyone Derives Different Meanings (1), Class (1), Cloud (1), Imagination (1), World (2), Everyone Achieving Their Specific Desires (1), Creation (1), Universe (1)	“"It is a confusion where everyone derives different meanings. Because people's lives and understanding of life differ according to their way of seeing things from life.” (S18)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Flexibility in use (25)	Individuality (5)	Equal Art (1), Designed Shoes (1), Everyone Climbing Trees (1), Painting (1), Van (a city) (1)	"It is like a painting. Because every viewer gets a different meaning." (S196)
Flexibility in use (25)	Difference (4)	A Colorful Flower Garden (1), Functional and Aesthetic Design (1), Rain (1), Weather (1)	"It is like the weather because it contains various weather events and conditions." (S184)
Flexibility in use (25)	Live-dynamic (4)	Drinking Water (1), Water (1), Nature (1), Rubber (1)	"It is like drinking water. Because it is a living thing that gets refreshed as you drink it." (S3)
Flexibility in use (25)	Imagination (1)	Fairy tale (1)	"It is like a fairy tale. Because it is a product of imagination." (S104)
Flexibility in use (25)	Complexity (1)	Knot (1)	"It is like a knot because it is very complicated." (S110)
Flexibility in use (25)	Utopian (1)	Happiness (1)	"It is like happiness, because it is something that will never be perfect." (S137)
Low physical effort (7)	Ease (5)	Equal Accessibility (1), Telephone (1), Automatic Opening Door (1), Technological Devices (1), Flexibility and Simplicity in Use (1)	"It is like access to equal conditions because it allows a person to meet their needs more easily." (S63)
Low physical effort (7)	Happiness/ well-being (2)	Chocolate (1), Sunny Sky (1)	"It is like chocolate. Because it is happiness." (S10)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Tolerance for Error (8)	Development-process (4)	Sustainability (1), It Is Not as Easy to Do As One Might Think (1), The Way to Happiness (1), Stream (1)	"It is like sustainability because it preserves and transforms the ordinary." (S109).
Tolerance for Error (8)	Precaution (2)	Social Media (1), Box (1)	"It is like social media. Because we can quickly access the information we want and determine whether it is safe or not." (S195)
Tolerance for Error (8)	Empathy (1)	Build Empathy (1)	"It is like building empathy. Because in order for everyone to understand, one must first understand the other person." (S52)
Tolerance for Error (8)	Hope (1)	Fenerbahçe (1)	"It is like Fenerbahçe. Because it is the never-ending belief that one day you will become a champion." (S202)
Simple and intuitive use (3)	Flexibility (2)	Library (1), Air (1)	"They can easily access the information they want.." (S194)
Simple and intuitive use (3)	Simplicity (1)	Main Purpose (1)	"It is like the main purpose. Because it makes it easier for everyone to understand." (S85)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Appendix 2. Comprehensive inventory of students' metaphors on universal design principles by faculty

Table a2.1. Metaphors of faculty of theology students on universal design and its principles

Category	Code	Metaphors	Sample Expression
Equitable Use (18)	Being equal and fair (10)	Water (1), Scales (1), Escalator (1), Islam Religion (1), Justice (1), Truth (1), Living on Religion (1), Cloud (1), Equity (1), Face (1)	"It is like an escalator. Because everyone goes up or down in the same way and at the same time." (S21)
Equitable Use (18)	Universality/ integrity/ inclusiveness (5)	A Kind of Item That Makes Our Life Easier (1), World (1), Statue of Liberty (1), Puzzle (1), Pieces of puzzle (1)	"It is like the World. Because it is a design that includes everyone." (S30)
Equitable Use (18)	Balance/order (3)	Scales (1), Religion (1), Life (1)	"It is like a scale. Because the universe was created on balance." (S6)
Perceptible information (8)	Guide (6)	Mind (1), Library (1), Sun (1), Star (1), Being a Muezzin (1), A Free Bird (1)	"It is like the mind. Because it leads to truth for those who can use it." (S5)
Perceptible information (8)	Need (1)	House (1)	"It is like the house. Because it is necessary for life." (S35)
Perceptible information (8)	Reflection / expression (1)	World of Imagination (1)	"It is like the World of Imagination. Because it reveals what is deep within the mind." (S16)
Flexibility in use (5)	Diversity/ relativity (3)	It is a Confusion Where Everyone Gets Different Meanings (1), Class (1), Imagination (1)	"It is like a classroom. Because it brings together all kinds of perceptions." (S20)
Flexibility in use (5)	Live-dynamic (2)	Drink Water (1), Water (1)	"It is like water. Because it is constantly flowing and extends everywhere." (S4)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Size and Space for Approach and Use (3)	Accessibility (1)	Information (1)	"It is like information. Because everyone can easily benefit from it." (S31)
Size and Space for Approach and Use (3)	Ideal (1)	An Unknown Utopia (1)	"It is like an unknown utopia. Because people believe in what they don't know." (S9)
Size and Space for Approach and Use (3)	Infinity (1)	Sea (1)	"It is like the sea. Because it is endless." (S1)
Low physical effort (1)	Happiness/ well-being (1)	Chocolate (1)	"It is like chocolate. Because it is happiness." (S10)

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Table a2.2. Metaphors of faculty of education students on universal design and its principles

Category	Code	Metaphors	Sample Expression
Equitable Use (14)	Universality/ integrity/ inclusiveness (8)	Tree (1), A Puzzle Where Different Pieces Can Fit Together (1), Feelings (1), Book (1), Freedom (1), Respect (1), Social Media (1), Puzzle (1)	"It is like a tree. Because it appeals to living things both above and below ground." (S199)
Equitable Use (14)	Being equal and fair (6)	Sky (1), Scales of Justice (1), Equal Environment (1), Water Accessible to Everyone (1), Still Water (1), Tree Roots (1)	"It is like an equal environment. Because everyone has equal rights in an equal environment, regardless of their situation." (S177)
Flexibility in use (6)	Individuality (3)	Everyone Climbing Trees (1), Painting (1), Van (a city) (1)	"It is like everyone climbing a tree. Because the notion of caring about someone's inner world is not prevalent in this society. Design, while individual and not universal, is a blessing for all societies." (S183)

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Category	Code	Metaphors	Sample Expression
Flexibility in use (6)	Diversity/ relativity (2)	World (1), Universe (1)	"It is like the world. Because it has so many different features and diversity." (S185)
Flexibility in use (6)	Difference (1)	Weather (1)	"It is like the weather. Because it contains various weather events and conditions." (S184)
Tolerance for error (4)	Caution (2)	Social Media (1), Boxing (1)	"It is like boxing. Because it is trying to protect yourself against a punch that you don't know where it will come from." (S200)
Tolerance for error (4)	Development-process (1)	Stream (1)	"It is like a stream. Because it both brings traces from where it comes and leaves traces where it flows." (S197)
Tolerance for error (4)	Hope (1)	Fenerbahçe (1)	"It is like Fenerbahçe. Because it's the never-ending belief that one day you will become a champion." (S202)
Simple and intuitive use (1)	Flexibility (1)	Library (1)	"It is like a library. Because they can easily access the information they want." (S194)
Low physical effort (1)	Ease (1)	Flexibility and Simplicity in Use (1)	"It is like flexibility and simplicity in use. Because we hold on to things that make our lives easier, they are simple and easy." (S178)
Size and Space for Approach and Use (1)	Infinity (1)	Sky (1)	"It is like sky. Because it is endless and has no beginning or end, everyone can see it." (S192)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Table a2.3. Metaphors of faculty of science and letters students on universal design and its principles

Category	Code	Metaphors	Sample Expression
Equitable use (11)	Being equal and fair (7)	Water (1), Equality and Design (1), A Dream to Come True (1), Paint Palette (1), Access (1), A Free Country (1), Equality (1)	"It is like equality and design. Because it shows and realizes that everyone is designed to be used equally." (S53)
Equitable use (11)	Universality/ integrity/ inclusiveness (4)	Means Everyone (1), A Book Everyone Should Read (1), Mevlana (1), Creative Thinking Style (1)	"It means everyone. Because to be universal, it has to be suitable for everyone." (S72)
Perceptible information (7)	Need (5)	Water (1), Home (1), A Rare Plant (1), Education (1), Breathing (1)	"It is like breathing. Because everyone needs it." (S78)
Perceptible information (7)	Comprehensibility (1)	Things We See When We Look Back (1)	"It is like the things we see when we look back. Because the universe consists of things we can see and interpret." (S65)
Perceptible information (7)	Reflectiveness / expression (1)	Free Mindset (1)	"It is like a free mindset. Because when people do something without any obstacles or fear, it makes them more comfortable and free." (S67)
Size and Space for Approach and Use (5)	Existence/ extinction (3)	Nature (1), Extinction (1), Each Person's Private World (1)	"It is like extinction. Because extinction is the inevitable end of everyone." (S61)
Size and Space for Approach and Use (5)	Ideal (1)	Keeping Imagination Alive (1)	"It is like keeping the imagination alive. Because people want to keep their dreams alive." (S70)
Size and Space for Approach and Use (5)	Infinity (1)	Drowning in the Ocean (1)	"It is like drowning in the ocean. Because only the gods have the power to do this." (S55)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Flexibility in use (2)	Diversity/ relativity (1)	Achieving Everyone's Desired Special Wishes (1)	"It is like everyone achieving their own special wishes. Because everyone's special wishes are different." (S76)
Flexibility in use (2)	Difference (1)	A Colorful Flower Garden (1)	"It is like a colorful flower garden. Because all the flowers in the flower garden are more beautiful than each other." (S73)
Low physical effort (1)	Ease (1)	Equal Accessibility (1)	"It is like access to equal conditions. Because it allows a person to meet their needs more easily." (S63)

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Table a2.4.Metaphors of faculty of engineering students on universal design and its principles

Category	Code	Metaphors	Sample Expression
Equitable use (13)	Being equal and fair (5)	Scales (1), Appealing to All Segments of Society (1), Gender Equality (1), Something That Should Happen (1), Scales of Justice (1)	"It is like appealing to every segment of society. Because every person is equal." (S133)
Equitable use (13)	Universality/ integrity/ inclusiveness (5)	Equality (1), Common Language (1), Clean Air (1), Pomegranate (1), River (1)	"It is like equality. Because it should be for everyone." (S131)
Equitable use (13)	Similarity (1)	Emotions (1)	"It is like emotions. Because everyone feels similar things." (S150)
Equitable use (13)	Balance/ order (1)	Justice (1)	"It is like justice. Because both sides of the scale must be equal." (S138)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Equitable use (13)	Sensitivity (1)	The Embodiment of Understanding (1)	“It is like the embodiment of understanding. Because it advises us to be more sensitive towards people.” (S125)
Perceptible information (5)	Valuable (2)	Treasure (1), Jewel (1)	“It is like a jewel. Because its value increases as it is processed.” (S134)
Perceptible information (5)	Need (2)	Water (1), Eating (1)	“It is like water. Because it is an important part of life.” (S126)
Perceptible information (5)	Guide (1)	Key (1)	“It is like a key. Because it helps everyone open their doors.” (S140)
Size and Space for Approach and Use (4)	Accessibility (3)	Perceptible Information (1), World of Software (1), Accessibility for Everyone (1)	“It is like the world of software. Because it recognizes no obstacles and is easily accessible.” (S143)
Size and Space for Approach and Use (4)	Infinity (1)	Sky (1)	“It is like the sky. Because it is a magnificent thing with no limits.” (S146)
Flexibility in use (3)	Individuality (1)	Equal Art (1)	“It is like equal art. Because everyone has different interpretations, there's only one drawing.” (S144)
Flexibility in use (3)	Utopian (1)	Happiness (1)	“It is like happiness. Because it is something that will never be perfect.” (S137)
Flexibility in use (3)	Live-dynamic (1)	Rubber (1)	“It is like rubber. Because it is flexible in use.” (S141)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Low physical effort (1)	Happiness/ well-being (1)	A Sunny Sky (1)	"It is like a sunny sky. Because it makes you feel peaceful and happy." (S130)

Note. *S refers to student; the number indicates the participant code.*

Table a2.5.Metaphors of faculty of sport sciences students on universal design and its principles

Category	Code	Metaphors	Sample Expression
Equitable use (12)	Universality/ integrity/ inclusiveness (6)	Simple and Intuitive Use (1), Pomegranate (1), Sharing (1), Respect (1), Puzzle (1), Escalator (1)	"It is like an escalator. Because it is something everyone uses in common." (S160)
Equitable use (12)	Being equal and fair (4)	School (1), Childhood (1), Oxygen (1), Living (1)	"It is like school. Because every individual has the right to study." (S153)
Equitable use (12)	Balance/ order (2)	Scales (1), Chain Links (1)	"It is like a scale. Because it is important to keep balance on both arms." (S172)
Equitable use (12)	Universality/ integrity/ inclusiveness (6)	Simple and Intuitive Use (1), Pomegranate (1), Sharing (1), Respect (1), Puzzle (1), Escalator (1)	"It is like an escalator. Because it is something everyone uses in common." (S160)
Perceptible information (6)	Need (4)	Tree (1), Water (1), Car (1), Oxygen (1)	"It is like water. Because it is a necessary substance." (S152)
Perceptible information (6)	Guide (1)	Key (1)	"It is like a key. Because it opens every door and provides convenience." (S164)
Perceptible information (6)	Reflectiveness/ expression (1)	Tree (1)	"It is like a tree. Because you reap what you sow." (S151)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Low physical effort (3)	Ease (3)	Telephone (1), Automatic Door (1), Technological Devices (1)	"It is like a telephone. Because it makes life easier. (S154)
Tolerance for error (2)	Development-process (2)	It is Not As Easy As It Seems (1), The Path to Happiness (1)	"It is like the path to happiness. Because everyone can only be happy by following a certain path." (S171)
Simple and intuitive use (1)	Flexibility (1)	Air (1)	"It is like air. Because it is simple and accessible." (S156)
Flexibility in use (1)	Individuality (1)	Designed Shoes (1)	"It is like a designed shoe. Because everyone designs the shoes they love." (S157)

Note. *S refers to student; the number indicates the participant code.*

Table a2.6. Metaphors of faculty of architecture students on universal design and its principles

Category	Code	Metaphors	Sample Expression
Equitable Use (8)	Universality/ integrity/ inclusiveness (6)	Feelings (1), Illusion (1), Door (1), Kebab (1), Book (1), Sphere (1)	"It is like a sphere. Because there is sphericity everywhere in the universe." (S89)
Equitable Use (8)	Being equal and fair (2)	Life (1), Imaginative Structures (1)	"It is like life. Because universal design is a right for everyone." (S101)
Perceptible information (6)	Clarity (2)	The Incarnation of the Spirit (1), Common Language (1)	"It is like the soul incarnated in a body. Because it concretizes something abstract." (S90)
Perceptible information (6)	Need (2)	Nature (1), Emotions and Senses (1)	"It is like emotions and senses. Because it appeals to human life." (S91)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Perceptible information (6)	Guide (1)	Sun (1)	“It is like the sun. Because it sheds light on everything.” (S107)
Perceptible information (6)	Reflectiveness/ expression (1)	Imaginary Buildings (1)	“It is like imaginary buildings. Because design reflects what we think. (S108)
Flexibility in use (4)	Diversity/ relativity (1)	Creating (1)	“It is like creating. Because each person's work is unique to the person.” (S94)
Flexibility in use (4)	Difference (1)	Rain (1)	“It is like rain. Because the drops are shaped according to the cold.” (S105)
Flexibility in use (4)	Dreaminess (1)	Fairy Tale (1)	“"It is like a fairy tale. Because it is a product of imagination." (S104)
Flexibility in use (4)	Complexity (1)	Knot (1)	“"It is like a knot. Because it is very complicated." (S110)
Size and Space for Approach and Use (4)	Accessibility (2)	Water (1), Easy Trends and Paths (1)	“It is like water. Because it is the most accessible thing everyone needs.” (S99)
Size and Space for Approach and Use (4)	Ideal (1)	Nutritional Needs (1)	“"It is like the nutritional need. Because every living thing has needs." (S103)
Size and Space for Approach and Use (4)	Infinity (1)	Ocean (1)	“It is like the ocean. Because it is an endless, limitless infinity.” (S106)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Tolerance for error (1)	Development-process (1)	Sustainability (1)	“It is like sustainability. Because it preserves and transforms the ordinary.” (S109).

Note. *S refers to student; the number indicates the participant code.*

Table a2.7. Metaphors of faculty of communication students on universal design and its principles

Category	Code	Metaphors	Sample Expression
Equitable Use (8)	Universality/ integrity/ inclusiveness (6)	Mother (1), Building a Connection (1), White (1), Nature (1), Kebab (1), Like a Mirror Held Up to Society (1)	“"It is like mother. Because it means the same thing everywhere." (S39)
Equitable Use (8)	Being equal and fair (1)	Scales (1)	“It is like the scale. Because equality is its goal.” (S44)
Equitable Use (8)	Balance/ order (1)	The Order Itself (1)	“It is like order itself. Because everything in the universe is the result of an order.” (S51)
Perceptible information (3)	Guide (2)	Audible Pedestrian Crossing (1), Guide (1)	“It is like an audible pedestrian crossing. Because it serves as assistance and therapy for visually impaired people.” (S36)
Perceptible information (3)	Need (1)	Bread (1)	“It is like bread. Because it is the most basic nutritional element.” (S45)
Size and Space for Approach and Use (3)	Infinity (2)	Space (2)	“It is like space. Because it has no end.” (S50)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Size and Space for Approach and Use (3)	Accessibility (1)	Easy, Comfortable, Straight Path (1)	“It is like an easy, comfortable, straight path. Because it is suitable for individuals to progress easily.” (S38)
Flexibility in use (2)	Diversity/ relativity (2)	Cloud (1), World (1)	“It is like the world. Because design is different for everyone, just like people in the world.” (S47)
Tolerance for Error (1)	Empathy (1)	Build Empathy (1)	“It is like building empathy. Because everyone needs to understand the other person in order to understand.” (S52)

Table a2.8. Metaphors of faculty of tourism students on universal design and its principles

Category	Code	Metaphors	Sample Expression
Equitable Use (9)	Being equal and fair (6)	Integrity (1), Equal Use and Flexibility (1), A Society Where Everyone Is Equal (1), A World Where Everyone Is Loved (1), Designing for Everyone's Situation (1), Being Unique (1)	“"It is like equal use and flexibility. Because everyone is a part of an equal life." (S114)
Equitable Use (9)	Universality/ integrity/ inclusiveness (2)	Mevlana (1), Meeting the Needs (1)	“"It is like meeting needs. Because it is about creating a design that suits everyone." (S119)
Equitable Use (9)	Balance/ order (1)	Laws of Life (1)	“It is like the laws of life. Because people live in an order.” (S116
Perceptible information (3)	Transparency (2)	Water (1), Transparency (1)	“It is like water. Because it is transparent.” (S121)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Perceptible information (3)	Reflection/ expression (1)	Mirror (1)	"It is like a mirror. Because in front of the mirror, our reflection appears; it is our equal, our twin." (S123)
Flexibility in use (1)	Live-dynamic (1)	Nature (1)	"It is like nature. Because there is life in it." (S115)
Size and Space for Approach and Use (1)	Infinity (1)	Sky (1)	"It is like the sky. Because it has no end." (S124)

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Table a2.9. Metaphors of faculty of fine arts students on universal design and its principles

Category	Code	Metaphors	Sample Expression
Size and Space for Approach and Use (4)	Infinity (2)	Earth (1), Ocean (1)	"It is like the earth. Because it is endless." (S80)
Size and Space for Approach and Use (4)	Accessibility (1)	Art (1)	"It is like art. Because it reaches the masses." (S83)
Size and Space for Approach and Use (4)	Ideal (1)	The Eye Opening to Truth (1)	"It is like an eye opening to the truth. Because human beings reflect their dreams with what they see." (S87)

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DOI: https://doi.org/10.17411/jacces.v16i2.724

Category	Code	Metaphors	Sample Expression
Equitable use (2)	Universality/ integrity/ inclusiveness (1)	Integrative Perspective (1)	"It is like a holistic perspective. Because every person can adopt the same mindset." (S84)
Equitable use (2)	Balance/ order (1)	Order within Chaos (1)	"It is like order within chaos. Because reflecting the styles of people living in different geographies within the world's population under a single roof demonstrates order within chaos." (S81)
Perceptible information (1)	Need (1)	Accommodation (1)	"It is like accommodation. Because it is something everyone builds and uses according to their needs." (S82)
Simple and intuitive use (1)	Simplicity (1)	Main Purpose (1)	"It is like the main purpose. Because it makes it easier for everyone to understand." (S85)
Flexibility in use (1)	Difference (1)	Functional and Aesthetic Design (1)	"It is like functional and aesthetic design. Because individuals with physical, mental, and emotional differences need to have a comfortable design." (S79)

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© Journal of Accessibility and Design for All (JACCES), Volume 16, Issue 2, 2026, ISSN: 2013-7087
DOI: https://doi.org/10.17411/jacces.v16i2.724

How to cite this article

Sivrikaya T., Türker-Yıldırım Ç., Kocaman R.T., Hasar D. (2026). An examination of students' metaphorical perceptions of universal design across different faculties. Bridging disciplinary knowledge and inclusive practice. Journal of Accessibility and Design for All, 16 (2), 139-175. https://doi.org/10.17411/jacces.v16i2.724

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