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Nurturing Affective Intelligence through Biophilic Design in Early Childhood Education: A Designers' Analysis

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ABSTRACT

Objective: Environmental crises, public policies, and shifts in cultural decision-making have diminished traditional opportunities for direct engagement with open spaces and nature. Moreover, such environments enhance children's emotional capacities, enhancing their social well-being by responding to their needs and interests. Hence, this study probed how designers perceive and apply biophilic design elements in preschool settings to foster emotional intelligence.

Method: To achieve this, a mixed-methods approach, combining Q-factor analysis with grounded theory was employed. Ten experts' perspectives were systematically analyzed using Q-factor analysis, allowing for the extraction of key indicators that define the relationship between biophilic design and emotional intelligence. This methodological approach ensures that findings are grounded in interdisciplinary insights, reinforcing the role of nature-integrated spaces in fostering emotional growth.

Conclusions: Based on the results of Q-factor analysis, four key dimensions of personal experience, social engagement, spatial characteristics, and ecological landscape play significant roles in shaping children's emotional capacities. The results call for a need to reevaluate current policies, with greater attention to children's lived experiences within nature-based, interactive settings.

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Introduction

Over the past decades, scholarly research on children's spatial preferences, activities, and access to open or natural environments has evolved considerably. Prior to the 1990s, studies focused on playgrounds, streets, and schoolyards with an emphasis on safety, physical development, and design (Harvey, 1989; Heusser & Adelson, 1986; Taylor & Vlastos, 1975; Wilkinson, 1985). In the 1990s, attention expanded to residential and neighborhood spaces, investigating children’s experiences and developmental outcomes in public urban areas (Andel, 1990; Herrington & Studtmann, 1998; Lowry, 1993; Valentine & McKendrick, 1997; Wood, 1993).

From the early 2000s onward, research increasingly emphasized the impact of spatial and environmental design in enhancing children's engagement with nature and outdoor settings (Andel, 1990; Dyment, 2008; Fjørtoft & Sageie, 2000; Kytta, 2004; Ozdemir & Yilmaz, 2008; Powell, 2007; Prezza, 2007; Taylor et al., 2002). This shift highlighted the link between open space and enriched learning, leading to frameworks such as outdoor education (Priest, 1986).

Recent studies continue to reinforce this trend: Chawla et al. (2022) underscore nature's role in fostering responsibility in children, while Fägerstam (2012) demonstrates how emotional experiences in natural settings deepen learning and improve focus.

Natural Spaces and Emotional Intelligence

Green spaces play a vital role in children’s social and emotional development by offering diverse environments tailored to their interests and needs. These settings promote collaboration and social interaction, reinforcing children’s interpersonal skills and collective engagement (Bell & Dyment, 2008; Szczepanski, 2009). Nature encourages cooperative behaviors through problem-solving and teamwork, further enhancing social competencies (Johnson, 2007; Rickinson et al., 2004). Sensory-rich experiences in natural environments also contribute to emotional regulation and psychological well-being (Rivkin, 1997). Such exposure not only nurtures peer relationships but also fosters civic awareness and community cohesion (Bowker & Tearle, 2004; Johnson, 2007).

To expand access to nature, particularly in dense urban settings, emerging technologies like virtual reality (VR) have been used alongside biophilic design strategies. VR enables immersive nature-based experiences that bridge ecological disconnection for urban children (Mirrahimi et al., 2023). This simulated engagement supports emotional development and encourages ecological appreciation. Chawla et al. (2022) demonstrate that interacting with natural environments cultivates self-awareness and emotional regulation in children—core attributes of emotional intelligence.

On the other hand, emotional intelligence refers to the ability to perceive, understand, and manage emotions in both individual and social contexts (Salovey & Mayer, 1990). Goleman (1995) broadened the definition to include empathy, self-awareness, and motivation, traits essential for personal and professional relationships. Mayer and Salovey (1990) and Goleman (1995) laid the theoretical foundation for emotional intelligence, emphasizing its malleability through education and experience. Rather than fixed traits, emotional and social intelligence are dynamic capacities that evolve during childhood and adolescence—periods marked by heightened cognitive and emotional development.

This developmental trajectory is supported by research illustrating the strong connection between emotional processes and learning. Fägerstam (2012) asserted that emotions and cognition are intertwined, and their integration enriches educational outcomes. Scholars such as Bar-On (1997), Ciarrochi et al. (2005), and Mayer and Salovey (1997) supported the idea that teaching emotional regulation fosters resilience, deepens engagement, and promotes effective problem-solving. Incorporating emotional awareness into pedagogical frameworks not only improves individual performance but enhances collective learning experiences.

When combined with intentional educational strategies, natural environments serve as optimal platforms for nurturing emotional intelligence and cognitive skills. These settings encourage children to explore, connect, and grow both emotionally and intellectually. Shams Dolatabadi et al. (2018, 2019) emphasize how nature-centric design fosters essential life skills including emotional resilience, social adaptability, and curiosity-driven problem-solving. Moreover, emotional intelligence thrives in these organic learning environments, where children build relationships, navigate challenges, and express themselves meaningfully.

Early childhood is a particularly critical window for emotional development. Several experts (e.g., CASEL, 2015; Elias et al., 2006; Mayer & Salovey, 1997) argue that foundational social and emotional skills must be cultivated during this phase to shape future outcomes. Besharat (2005) noted that young children start egocentric but gradually gain complex understandings of social structures. Sharifi-Daramadi (2007) underscored that emotional intelligence at this stage enhances both cognitive flexibility and interpersonal relationships, equipping children with tools to manage academic and social demands.

Modern education frameworks now prioritize active learning that values analytical thinking, self-discovery, and meaningful engagement. These models reject rote memorization in favor of fostering ethical, responsible, and socially conscious individuals (Committee for Children [SEL], 2016; Sharifi-Daramadi, 2007). Educational systems, as Sharifi-Daramadi (2007) asserted, should aim to produce learners who are not just informed but are empathetic, resilient, and capable of contributing confidently to evolving communities.

Elias et al. (2003; cited in Mirrahimi et al., 2011b) confirmed that emotional and social intelligence can be cultivated through strategic behavioral interventions and emotionally rich educational environments. Johnson (2007) further advocated for incorporating values, forward-thinking behaviors, and lifestyle awareness into education to enhance learning outcomes. This perspective intersects with spatial design and environmental psychology. Also, Akrami (2005) highlighted that carefully designed environments foster ethical engagement and interpersonal growth, reinforcing personal development and well-being. Thus, emotional intelligence should be woven not only into pedagogical strategies but into the design of educational spaces and urban planning initiatives.

Key components such as self-regulation and self-development are central to emotional intelligence and closely tied to children's capacity to form relationships and manage emotions. Malek (2012, p. 129) asserted that these qualities—alongside teamwork and social interaction—should be systematically integrated into curricula. Embedding emotional management within early education supports both self-awareness and cooperative engagement, preparing children to effectively navigate diverse social contexts.

Future research is vital to deepening our understanding of how natural environments influence personal and social development. Mirrahimi et al. (2011b) suggested exploring how biophilic engagement strengthens relationships and fosters emotional growth. Davies and Hamilton (2006; cited in Knight, 2009) as well as Eloquin and Hutchinson (2011) emphasized that open spaces provide unique opportunities for interpersonal exploration, confidence-building, and emotional resilience. Furthermore, Rickinson et al. (2004) proposed a multidimensional research approach that draws from environmental psychology, urban design, and education to optimize developmental outcomes for children.

These studies collectively highlight the importance of integrating biophilic principles with pedagogy to create immersive, nature-based learning experiences. Khamis (2009) supported this claim by showing that engagement with nature enhances children's emotional confidence, group cooperation, and social responsiveness. Such natural encounters help nurture intrinsic motivation and empathy-key attributes of emotional intelligence.

Natural Design and Biophilic Approaches

Contemporary research increasingly affirms that immersion in natural environments helps regulate stress and fosters emotional recovery. These restorative effects align with psychological revolution theory, demonstrating nature's role in reducing negative thought patterns and promoting well-being. According to attention restoration theory, a balanced relationship between nature and built environments significantly supports both physical and mental health (Matsuoka, 2010). Hartig et al. (2014) found that individuals with greater access to natural settings show enhanced health and resilience to stress-related conditions, while Berto (2018) reported improved cognitive flexibility and decision-making linked to nature exposure. Similarly, Sadeghi et al. (2024) emphasized that embedding urban activities within biophilic frameworks encourages social interaction and reduces stress, thereby reinforcing a sense of community and belonging.

McHarg's pioneering work on ecological design advocated for precise environmental analyses as a foundation for effective urban planning. His GIS-informed insights revealed that proximity to natural spaces correlates with elevated physical and psychological health, while reduced green infrastructure contributes to increased social and psychological disorders. The reintegration of nature in urban living, as emphasized by Shahcheraghi and Bandarabad (2023), is now regarded as essential for population well-being. This reintegration occurs via three major strategies: instrumental (nature as usable resource), ecological (enhancing environmental resilience), and symbolic (ethical and psychological values) (Kamelnia, 2006; cited in Shahcheraghi & Bandarabad, 2023). The symbolic approach informs healing landscapes, urban parks, and biophilic design initiatives.

Biophilia, a concept rooted in humanity's evolutionary connection with nature, captures our innate tendency to affiliate with natural life systems. Wilson argued that humans exhibit more harmonious and socially refined behaviors in natural settings, and that direct contact with nature fosters deeper understanding and meaning (Bell et al., 2001). Kellert and Wilson (1993) emphasized that this bond, forged since early human development, underpins both survival and ecological sustainability. Yet, modern urbanization and dense architectural environments have diminished this connection, contributing to psychological alienation and raising critical concerns about long-term well-being.

To address this disconnection, biophilic design emerged as a strategic response that integrates nature into architectural and urban contexts. Kellert (2008) defined biophilic design as more than just the inclusion of plants—it entails meaningful interactions between people and nature that improve emotional and social health. Recent findings show biophilic environments positively affect learning, creativity, job satisfaction, productivity, stress mitigation, and environmental awareness (Sadeghi et al., 2024). This design philosophy reinforces the reciprocal relationship between humans and ecological systems, creating built environments that support community resilience and emotional richness.

Biophilic design operates through two core modalities. Direct Connection involves incorporating sensory elements like natural light, ventilation, vegetation, and organic materials to improve atmosphere and emotional response. Indirect Connection uses ecological patterns and symbolic imagery to evoke a natural essence in urban design (Kellert, 2008). Kellert (2012) proposed eight psychological pathways through which individuals relate to nature: aesthetic appreciation, curiosity, aversion, material use, emotional attachment, dominance, spiritual connection, and symbolism. These represent a nuanced spectrum of human-nature engagement in both conscious and instinctual dimensions.

Derr and Lance (2012) argued that enriching everyday life through nature integration in architectural and interior design is a foundational need. Building upon this, Derr and Kellert (2013) identified essential biophilic design elements for children's environments, such as energy systems, materials, water, land, and ecosystems. Their studies emphasize the necessity of fostering environments that balance function and emotional experience. Specifically for children, biophilic spaces should offer sensory richness, opportunities for movement, spontaneous exploration, adaptive features, refuge, and transformation, supporting psychological growth and creativity (Derr & Lance, 2012). Shahcheraghi and Bandarabad (2023) propose biophilic design strategies with an environmental psychology perspective, as outlined in Table 1.

Table 1. Biophilic Design Recommendations (Shahcheraghi & Bandarabad, 2023)

Biophilic Design Recommendations
Facilitating social interactions through the design of comfortable and inviting spaces that encourage social engagement.
Circulation and spatial arrangement to foster informal and friendly interactions by incorporating design elements that guide people into spaces and encourage dialogue and connection.
Territorial definition in design strategies to create a sense of ownership and comfort within spaces.
Providing restorative environments by creating calm and quiet spaces enriched with sensory stimuli to support relaxation and emotional renewal.
Enhancing sensory adaptability through access to daylight, variations in color, patterns, textures, and natural ventilation.
Ensuring personal privacy by establishing clear boundaries for individual and private spaces.
Maintaining appropriate distances between individuals to support comfort and autonomy.
Creating visually appealing landscapes inspired by natural surroundings.
Incorporating complexity in design to reduce uniformity and integrate organic forms and structures.
Sound level control harmonized with natural acoustic environments.
Enabling social interaction modulation by allowing users to navigate through spaces or adjust personal environments to regulate social engagement.
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In the Iranian context, Aref and Taheri (2015) distilled biophilic design into three localized dimensions: Direct Experience emphasizes sensory diversity and physical access to nature; Indirect Experience incorporates nature-mimicking features, organic materials, and visual connections; Spatial Experience includes complexity, ambiguity, shelter, multiple perspectives, and ecological continuity. Their classification helps adapt global biophilic principles to regional cultural and ecological needs. Complementing these frameworks, Browning et al. (2014) synthesized foundational research into three core design themes: *Direct Presence of Nature*, which embeds organic elements in space; *Patterns and Forms Inspired by Nature*, encouraging biomorphic aesthetics; and *Human Affinity for Risk and Discovery*, fostering engagement and exploration. These principles offer practical guidance for creating immersive and emotionally resonant spaces across age groups and geographic settings. Altogether, this body of work underscores that biophilic design is not merely an aesthetic preference—it is an evidence-based necessity for enhancing individual well-being, fostering social cohesion, and ensuring the sustainability of urban life. The symbolic, emotional, and ecological functions of nature must be thoughtfully integrated into contemporary design strategies to restore the broken links between humans and their environments.

Finally, although numerous studies have emphasized the psychological and developmental benefits of nature-based environments for children, the integration of biophilic design principles into preschool spaces remains insufficiently addressed from the perspective of designers. Moreover, while existing research highlights the role of natural elements in enhancing emotional regulation, social interaction, and cognitive development during early childhood (Fadda, et al., 2023; Shams Dolatabadi et al., 2019), there is a lack of structured frameworks that translate these findings into spatial strategies tailored for preschool environments. Recent studies have underscored the importance of aligning biophilic attributes with children's emotional and sensory needs (Sariman Ozen & Ünal, 2021), yet few have explored how designers conceptualize and prioritize these dimensions in practice. Thus, this study sought to address this gap by examining how designers perceive and apply biophilic design elements in preschool settings to foster emotional intelligence. By bridging psychological theory with design methodology, the research aims to offer a comprehensive framework that supports the creation of emotionally responsive and developmentally enriching environments for young children.

Materials and Methods

Design of the Study

This study investigated the link between biophilic design and the emotional intelligence of preschool children by employing a mixed-methods approach, combining Q-factor analysis with grounded theory.

Participants

To ensure a comprehensive, interdisciplinary exploration of biophilic design in preschool children's spaces, open-ended interviews were conducted with ten expert faculty members-six specializing in architecture and urban planning and four in psychology-affiliated with the University of Science and Industry, Shahid Rajaee University, Art University of Isfahan, Alzahra University, and the School of Fine Arts in Tehran. The first interviewee was selected through theoretical sampling, and subsequent participants were recruited via snowball sampling until no new thematic insights emerged, thereby achieving theoretical saturation (Biernacki & Waldorf, 1981; Noy, 2008; Saunders et al., 2018). The adequacy of the sample size was subsequently confirmed using the Kaiser–Meyer–Olkin test.

Procedure

After recruiting and interviewing the participants, in the analysis phase, a grounded theory approach was employed: initial concepts and key points were systematically categorized and subjected to open coding to develop conceptual continuums that bridge architectural and psychological perspectives on children's emotional intelligence. To establish connections between the identified concepts, conceptual continuums were developed. These refined concepts were then reassessed and adjusted based on expert feedback. During the coding phase, paired comparisons of diagrams helped identify shared thematic patterns. Conceptual intersections across each axis were labeled to facilitate a broader categorization of the entire continuum.

The findings were then organized into a goal-content table, where the extracted concepts were designated as research objectives. The developed conceptual frameworks and continuums underwent expert validation to ensure accuracy. Ultimately, the goal-content table informed the design of the research questionnaire, ensuring alignment with the study's overarching objectives.

Results

Factor Analysis

At this stage, the questionnaire data was examined using Q-factor analysis, which enabled the identification of four distinct perspectives among participants. Within each category, responses with the highest (9–10) and lowest (0–1) scores were pinpointed. Common questions across these perspectives were reassessed through a condensed follow-up questionnaire, ensuring a refined approach to categorization. The analytical process was then repeated for the revised questionnaire to further validate patterns and insights.

The overall KMO measure of sampling adequacy was .657, which according to Kaiser (1974), falls in the "mediocre" range, indicating that the dataset is adequate for factor analysis. Bartlett's test of sphericity was significant ($\chi2(45)=289.67$, $p<0.001$), confirming adequate inter correlations among variables. Together, these results verify that both the sample size and data quality are sufficient for extracting reliable factor solutions.

Table 2. Kaiser–Meyer–Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity

Test	Value
Kaiser–Meyer–Olkin Measure of Sampling Adequacy	.657
Bartlett's Test of Sphericity – Approx. χ^2 (df = 45)	289.67
Significance (p)	< .001

Q-Factor Analysis

In Q-factor analysis, the emphasis is placed on analyzing the respondents rather than the individual responses. This methodological approach enables the identification of distinct perspectives on the subject matter, allowing researchers to categorize thought patterns within a given population.

The rotated data matrix reveals factor loadings exceeding ±.30, indicating significant contributions of specific variables to each identified factor (Table 3).

Table 3. Variance of Data after Factor Rotation

	Cumulative Percentage	Variance Percentage	Total	Cumulative Percentage	Variance Percentage	Total
1	28.041	28.041	2.804	35.403	35.403	3.540
2	47.517	19.476	2.947	59.553	24.150	2.415
3	65.529	18.012	1.801	71.832	12.279	1.227
4	82.035	16.506	1.650	82.035	10.203	1.020

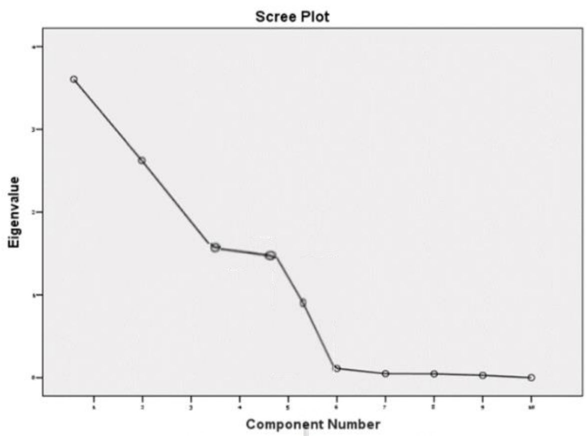
The classification of experts within each group is systematically detailed in Table 4, outlining how perspectives align across distinct categories.

Table 4. Classification of Experts Based on their Perspectives in the Second Delphi Round

Group	Experts
first group	2, 6, 8
second group	4, 7, 1
third group	3, 10
fourth group	5, 9

Following data rotation and analysis of responses from 10 experts, four key factors emerged. The findings indicate that approximately 82% of expert viewpoints were aligned, suggesting a shared recognition of reality across participants. This high degree of consensus reinforces the robustness of the identified perspectives, supporting the validity of the study's conclusions.

Figure 1. Identification of Four Factors in Expert Opinion Analysis, Point of Slope Change, and Factor Rotation Inflection.



To further validate this analytical approach and uncover shared cognitive orientations within each category, the highest (8–9) and lowest (0–1) scoring questions were extracted again. The frequency of occurrence of these questions across expert responses allowed for the identification of consistently emphasized themes.

Table 5. Rotated Data Matrix

Variant	1	2	3	4
Var0002	.860			
Var0006	.960			
Var00008	.871			
Var0004		.324		
Var00007		.832		
Var0001		.832		
Var0003			.856	
Var00010			.838	
Var00005				.761
Var0009				.803

By assigning conceptual labels to the core ideas emerging from each category, experts delineated the key factors shaping biophilic design principles in relation to emotional intelligence.

Table 6. Spatial Elements in Each Category

No. of Group	Identified Factors	No. of specialists	Description of Related Elements/ Factors
1	Personal Experience	2, 6, 8	providing natural views / visual connection multi-sensory play through sensory stimulation for self-awareness sense of discovery and fulfilling curiosity freely experiencing emotions and a sense of liberation to boost self-confidence
3	Social Experience	3, 10	movement and physical play social interactions and communication enabling cooperative, group-based, and rule governed play
2	Spatial Nature And Design	1, 4, 7	sense of place spatial diversity to enhance sensory richness use and imitation of biomorphic and natural patterns, forms, and textures adaptability for attraction and excitement natural materials and colors ensuring optimal visual access complexity and mystery dynamic natural lighting aesthetic appeal
4	Ecological Landscape	5, 9	connection with the ecological environment sense of responsibility toward nature biodiversity complexity and order ecosystem

Based on the results of Q-factor analysis, four key dimensions of personal experience, social engagement, spatial characteristics, and ecological landscape were found as the key factors in shaping children's emotional capacities.

Discussion

This study responds to the emerging link between biophilic design and the emotional intelligence of preschool children by employing a mixed-methods approach, combining Q-factor analysis with the grounded theory. Based on the results of Q-factor analysis, four key dimensions of personal experience, social engagement, spatial characteristics, and ecological landscape play significant roles in shaping children's emotional capacities. Each of these dimensions contributes to fostering self-awareness, interpersonal connections, and sensory engagement. Personal experience emphasizes individual emotional responses to natural elements, while social aspects focus on the ways children interact and collaborate in biophilic environments. Spatial characteristics explore the adaptability and sensory complexity of these settings, and ecological nature and landscape highlight the immersive role of natural systems in emotional intelligence cultivation. This classification aligns with Kellert's (2012) theoretical foundation and Aref and Taheri's (2015) localized design dimensions, both emphasizing direct and indirect engagement with nature through spatial design.

The findings indicated that nature-integrated environments not only enhance components such as self-awareness and empathy, but also strengthen group interactions, a sense of belonging, and social responsibility which is in line with the findings of Bell and Dyment, 2008; Chawla et al., 2022; as well as Shams Dolatabadi et al., 2018, 2019. In underserved urban contexts, the incorporation of virtual reality (VR) within biophilic design emerges as a novel strategy for recreating nature-oriented experiences (Mirrahimi et al., 2023). Particularly in urban schools, such applications may bridge the gap in nature access by offering interactive, immersive, and emotionally stimulating environments. Also, expert perspectives revealed a notable consensus regarding the meaningful relationship between biophilic design and emotional intelligence in children, affirming the credibility and coherence of the findings.

Conclusion

The reduced human-nature connection has led to significant psychological effects, particularly among children. Numerous studies highlight the pivotal role of green and natural environments in enhancing social well-being by offering diverse spaces that respond to children's needs and interests, thereby addressing the aforementioned issues. Creating a spectrum of sensory variations fosters enriched emotional development in children and effectively regulates their emotions. Additionally, such environments enhance children's emotional capacities, including self-confidence, group interactions, dynamic communication, exposure to diverse emotions, and motivation for learning—elements closely tied to emotional intelligence. In this regard, urban design, architecture, and landscape architecture hold substantial potential for preserving and reinforcing nature experiences within contemporary built environments.

This study goes beyond conventional cognitive learning frameworks by employing a biophilic approach tailored to children's developmental needs, examining its influence on emotional intelligence. The primary objective was to identify biophilic design characteristics that effectively support the enhancement of children's emotional intelligence. Incorporating nature into educational frameworks strengthens group dynamics and encourages responsibility, emotional awareness, and peer communication. Natural spaces foster immersive experiences that go beyond academic learning, supporting holistic development. By weaving these principles into curriculum and spatial design, children can grow into emotionally balanced and socially competent individuals prepared to face real-world complexities.

Furthermore, this study underscores that children's spaces should not be merely functional, but rather multisensory, complex, and exploratory-sparking curiosity, emotional expression, and self-liberation. The results, grounded in design perspectives, demonstrate that blending aesthetic and psychological principles in children’s spatial design improves both learning and social behavior. Such integration can establish a foundation for sustainable, human-centric education. Applying this approach to schools and child-oriented urban spaces calls for a reevaluation of current policies, with greater attention to children’s lived experiences within nature-based, interactive settings.

Given the dynamism of emotional development in early childhood and the need for psychologically, socially, and sensory responsive environments, this research proposes a path for designing emotionally enriching and biophilic learning spaces-laying the groundwork for inclusive, child-centered educational strategies. Integrating developmental psychology with environmental design-especially through emotional intelligence theory may also provide designers with practical tools to enhance the quality of educational environments.

Author Contributions

Hosna Sadat Shams Dolatabadi; methodology, validation, formal analysis, investigation, data curation, writing original draft preparation, Zahra Sadeghi; writing review and editing, visualization, supervision. Both authors have reviewed and agreed to the published version of the manuscript.

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Conflicts of interest

The authors declare no conflicts of interest.

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