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Effects of Childcare Classroom Physical Environment on the Behaviour of Children in Chinese Kindergarten – A Review

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ABSTRACT

Children's participation in quality Early Childhood Education and Care (ECEC) programs has been shown to positively influence their physical, cognitive, and social development. Previous research has examined how environmental features relate to children's social and play behaviours using both quantitative and qualitative methods. However, there remains a lack of in-depth studies focusing on the physical elements within kindergarten classrooms and their effects on children's actions and behaviours in the Chinese context. This review aims to explore the dynamic process of child-environment interaction within kindergarten classroom settings. Based on this, the study proposes an eco-psychological framework of affordance to conceptualise the interconnectedness between children and the classroom environment. Future studies are encouraged to empirically validate this framework to further understand the child-environment relationship.

INTRODUCTION

Early childhood is widely recognised as a critical period for development, and contemporary child development experts (Melhuish et al., 2015; Peisner-Feinberg, 2004; Van Huizen & Plantenga, 2018; Von Suchodoletz et al., 2023) consider it a sensitive time when developmental trajectories are first established. The global expansion of Early Childhood Education and Care (ECEC) aligns with policy efforts, such as Goal 4 of the United Nations Sustainable Development Goals (SDGs), which calls for universal access to at least one (1) year of preschool education (United Nations, 2015). In response, the Chinese government has substantially supported early childhood education through improved educational standards and

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increased funding over the past decade (Ministry of Education, 2018). After two (2) decades of research, it is widely accepted in academia that children who participate in quality ECEC programs often demonstrate enhanced cognitive, behavioural, and socio-emotional outcomes compared to their non-participating peers (Huang & Siraj, 2023; Pianta et al., 2021; Rao et al., 2012). Furthermore, ECEC plays a fundamental role in supporting children's development up to school age (Lenes et al., 2022). Likewise, investigating ECEC's physical environment is essential for promoting children's well-being and development within the Chinese context.

Despite the research on environmental influences being interdisciplinary and complex, the primary research framework on environmental factors has traditionally centred on the interaction between individuals and their contexts; the ECEC environment is no exception. Thus, this review categorises the ECEC environment into two (2) dimensions, physical and social, encompassing both tangible and intangible elements. The physical environment of ECEC refers to aspects like building structures, physical materials, resources, and furniture in both indoor and outdoor spaces (Benchekroun et al., 2020; Berti et al., 2019; Sando & Sandseter, 2020). A recent study by Tamblyn et al. (2023a) introduced the concept of a sensory environment in ECEC settings, initially discussed by Drahota et al. (2012) for evaluating sensory interventions in hospital contexts and their effects on adult health outcomes. Research on the physical environment also includes architectural design and sensory features such as colour, temperature, and lighting (Higgins et al., 2005; Morrow, 2018). Thus, understanding both physical and sensory environments is essential for a comprehensive evaluation of children's perceptions and interactions within educational settings. However, in the Chinese ECEC research paradigm, the focus largely remains on educational pedagogy, including teachers' philosophies (Liu et al., 2022), classroom management (Ye, 2015), and teaching strategies (Xu & Qin, 2021). Although some researchers recognise the importance of the physical environment on children's development (e.g., Luo, 2023; Ma & Hao, 2024), aspects like spatial layout, organisation of functional objects, and material quality are still overlooked.

In addition to the physical environment, the social environment, which differs significantly from the home setting, presents unique challenges for children. The social environment in ECEC includes five (5) core components identified in prior studies: teacher-child relationships (Özen-Uyar & Aktaş-Arnas, 2023; Rudasill & Rimm-Kaufman, 2009; Sabol & Pianta, 2012; Zhao et al., 2024), peer relationships and interactions (Howes et al., 1988; Klesges et al., 1990; Martin-Beltrán, 2017), classroom climate and atmosphere (Evans et al., 2009; Fiksl & Aberšek, 2014), cooperative and collaborative learning (Jin & Moran, 2018), and classroom management (Aksoy, 2020; Şahin-Sak et al., 2018). These factors substantially impact children's behaviours and outcomes, influencing social competence (Huang & Siraj, 2023), emotional well-being (Abed et al., 2016; Mayr & Ulich, 2009), academic motivation (Brody et al., 2018), internalising problems (e.g., anxiety, depression), and externalising problems (e.g., aggression, conduct issues) (Prinstein & Giletta, 2016; Stenseng et al., 2016). Although the effects of the social environment on children's development have been well-documented, the interplay between social and physical environments remains underexplored. For example, in a British preschool context, Huang (2017) examined how social environments, influenced by physical elements like marked boundaries and movable furnishings, impacted children's play behaviours. However, notable socio-cultural differences exist between British and Chinese ECEC settings. In British playrooms, layouts are often fixed, with stationary play equipment, while in Chinese classrooms, play materials are typically mobile (Huang, 2021), leading to differing child behaviours across contexts. Therefore, the current study aims to comprehensively examine children's engagement within ECEC environments by integrating physical and social environmental factors from a Chinese perspective.

CHINA'S EARLY CHILDHOOD EDUCATION AND CARE ECEC

In China, kindergarten (or Yòuéryuán) is designed for children aged three (3) to six (6) and serves as the primary form of early childhood education (Zhu, 2009). Most Chinese kindergartens use an age-based

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system to group children into three (3) grades: lower (Xiǎobān), middle (Zhōngbān), and upper (Dàbān) classes (Wu et al., 2022). Additionally, a specialised "preschool class" (Xuéqiánbān) focuses on preparing children aged five (5) to six (6) for primary school with an academic-oriented curriculum. Currently, approximately 38% of kindergartens are public, while the remainder are private and rely on parental fees with minimal government subsidies for operational costs (Ministry of Education, 2023).

Since the establishment of the first kindergarten in 1903, China's early education system has drawn from Japanese, Soviet, and American educational models (Huang et al., 2019). In recent decades, however, preschool education has evolved significantly, shifting from a teacher- and academically-centred approach to one (1) that emphasises child-centred and play-based learning, aiming to support children's holistic development (Ministry of Education, 2001; Huang & Siraj, 2023). National policies continue to prioritise quality ECEC and children's developmental outcomes. Additionally, nearly 90.3% of kindergarten teachers in China now hold a college degree or higher (Ministry of Education, 2023).

China's national curriculum framework has set developmental goals across five (5) key domains: health, language, social, science, and art, and requires kindergartens to develop learning plans accordingly (Ministry of Education, 2019). Many kindergartens have structured their curricula around these areas (Chen, 2018). In classroom spatial layout, functional kindergartens often use flexible furniture arrangements to create activity zones that support diverse developmental objectives. Aside from teaching and play, classrooms also accommodate dining, napping, storage, and toileting. Typically, Chinese kindergarten classrooms are designed as open, enclosed spaces with corridors serving as communal areas, occasionally used for group activities. Compared to the semi-open layouts common in Nordic or Western kindergarten classrooms, Chinese classrooms offer fewer private spaces for children, a design choice influenced by the need for effective teacher supervision. Chinese classrooms are generally more spacious and functional than those in some residential layouts.

In terms of evaluation systems, Li et al. (2014) developed the Chinese Early Childhood Environmental Rating Scale (CECERS), adapting the widely used Early Childhood Environmental Rating Scale-Revised Edition (ECERS-R) by adding a collectivist teaching evaluation module suited to the characteristics of Chinese preschool education. Additionally, the Chinese Kindergarten Environmental Rating Scale (CKERS) (Liu, 2008) provides a scientifically rigorous foundation for assessing the quality of ECEC in China. Moreover, the nature of the school also impacts classroom quality; public kindergartens in China generally demonstrate higher quality than private ones due to more favourable policies (Huang & Siraj, 2023). The location of preschools (rural or urban) further influences classroom quality, as teachers in rural areas often have limited access to early childhood education and professional development opportunities (Yang & Rao, 2021). However, there is currently a lack of evaluation tools specifically focused on the physical environment dimension of kindergartens.

Previous studies and evaluation systems are primarily pedagogically oriented, focusing on children's performance and development from a teacher-centred perspective. Although the Chinese government has introduced new requirements for the layout, functionality, and infrastructure of kindergarten indoor spaces (Li, 2022), many public and especially private kindergartens still reveal deficiencies in their interior spatial design. Questions such as how children perceive their environment and what they need or do not need during play sessions remain largely unaddressed by architects, interior designers, and facility managers. For instance, common issues include a lack of vertical communication spaces for children (Xu, 2015), excessive uniformity in furniture and materials (Dong, 2007), and low space utilisation (Chen, 2018; Dong, 2007; Li, 2022). Many kindergarten classrooms are designed similarly to conventional classrooms, with spatial components—such as poorly placed play materials and inefficient use of space—that lead to limited utility and reduced affordances (Kyttä, 2003). Consequently, in many developing countries, including China, traditional kindergarten classroom settings do not adequately support children's cognitive and social development. In other words, they fail to foster the diverse interests and developmental capacities of children (Dyment & Bell, 2007; Karaca et al., 2020). Although previous studies have highlighted challenges

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in kindergarten classroom design, issues like uniform classroom layouts across age groups persist (Huang, 2021). Therefore, there is an urgent need to improve the quality of kindergarten classrooms in China to accommodate a range of activities for children of different ages. To achieve this, examining the environment from a child-centred perspective, focusing on their play behaviours and social interactions is essential.

To date, while the nation is currently vigorously developing the quality of ECEC, researchers have explored its correlation with children's development and outcomes in terms of pedagogical practice and quality assessment, however, what about the material and social environment of kindergarten classrooms? There is indeed a small portion of assessment content on physical environment creation in the studies (Shi, 2019; Wang, 2021). However, there is still rare in this dimension that has paid attention to the relationship between ECEC physical environmental traits and children's behavioral outcomes, especially the exploration of environmental perception from children's perspective. Therefore, this study aims to explore the impact of the physical environment on children's social and play behaviours, as well as their awareness of classroom space, in the context of China's ECEC.

THEORETICAL BACKGROUND OF ECEC ENVIRONMENT ON CHILDREN'S PERFORMANCES

From a historical perspective, educational buildings significantly influence users' experiences and shape their behaviour (Burke & Whyte, 2021). In the context of ECEC, it is essential to consider the factors that affect classroom settings and spatial design (Tamblyn et al., 2023b). Previous research on classroom environments suggests that spatial characteristics often reflect the underlying pedagogical philosophy, teaching style, and cultural context of an educational setting (Berti et al., 2019; Musatti & Mayer, 2016). Although teaching is the classroom's primary function, studies have underscored the importance of the physical environment in early childhood education (van Liempd et al., 2020). The relationship between spatial arrangement and children's development is recognised as an essential aspect of curriculum design and educational practice. For example, in the Reggio Emilia approach to early childhood education in Italy, carefully designed aesthetic spaces are seen as the "third teacher" (Strong-Wilson & Ellis, 2007). Similarly, Austrian architect and educator Rudolf Steiner emphasised the importance of the physical environment in educational settings, arguing that artificial environments can stimulate thought (Uhrmacher, 2004). In Japanese educational contexts, Ferguson and Kuby (2015) proposed that preschool spaces should be viewed not as static containers but as dynamic, garden-like environments. Additionally, research in Nordic ECEC settings has shown that the availability of affordances in indoor and outdoor spaces significantly impacts children's physical activities and positive behaviours (Kyttä, 2003; Sando & Sandseter, 2020; Sandseter et al., 2022).

Research on the physical environment of ECEC is well-developed and plays a crucial role within globalised educational practices and evaluations. However, studies focusing specifically on the impact of physical environmental factors on children's free play behaviours, especially in indoor spaces, remain sparse. For instance, van Liempd et al. (2018) observed that Dutch children aged one (1) to four (4) showed deeper exploratory behaviours in playrooms when tables were available, suggesting that table positioning in childcare facilities may stimulate exploration. Nonetheless, the lack of studies on children aged four (4) to six (6) and fundamental differences between Dutch and Chinese classroom settings limit this implication's applicability in China. Additionally, Maxwell's (2007) Classroom Rating Scale provides a tool for evaluating classroom quality in relation to children's social and cognitive competencies, finding that appropriate adjacency supports children's task focus. However, the scale lacks specificity on the ideal proximity between learning spaces and overlooks the fluidity of social interactions. Assessing such dynamic social engagements through a post-evaluation tool remains challenging. Consequently, research on childcare physical environments should adopt a child-centred perspective, observing real-time actions and

https://doi.org/10.24191/bej.v22i2.1802

behaviours. To deepen understanding of children's behaviours, it is essential to examine their sensory perceptions of their environment.

Children engage with the ECEC environment through eight (8) sensory systems: visual, auditory, olfactory, gustatory, tactile, vestibular, proprioceptive, and interoceptive (STAR Institute, 2023). Tamblyn et al. (2023) reviewed research on sensory environments in healthcare and applied insights to ECEC, defining the sensory environment as any element perceived through sight, sound, touch, or smell, including spatial layout, noise levels, sensory materials, and furniture. This expanded perspective broadens the scope of research in childcare environments. Prior studies indicate that children integrate sensory information from their surroundings (Miller et al., 2009), and that chaotic, noisy, or crowded environments can negatively impact both children's behaviour and educators' teaching strategies (Jeon et al., 2016; Wachs et al., 2004). Understanding individual sensory needs can support personalised learning (Lersilp et al., 2021). Several theoretical models explore the effects of physical and sensory environments on children's development. For example, the optimal stimulus hypothesis proposes an inverted U-shaped relationship between stimulus level and developmental outcomes, where development is maximised at an optimal level of stimulation (Wachs, 1977). Meanwhile, ecological perceptual theory suggests that children perceive and respond to their environments dynamically through affordances. Many sensory aspects are, in fact, products of physical factors, leading some researchers to view the sensory environment as an extension of the physical setting (Bayramzadeh et al., 2021). Therefore, this study examines not only the physical environment in ECEC but also the sensory environment's influence on children's behaviour and development. Exploring children's perceptions through the lens of affordance provides new insights into child-environment interactions in childcare settings.

The social environment, embedded within ECEC, is integral to children's experiences. It encompasses interpersonal dynamics, relationships, and interactions in both indoor and outdoor spaces (Huang, 2017). In the ECEC classroom, the social environment includes the quality of relationships between children, teachers, and caregivers, as well as the overall social atmosphere and norms. Though often perceived as extensions of physical spaces, social environments are intangible and function as a web of connections among children, peers, and educators (Acar et al., 2018; Özcan et al., 2023; Salminen et al., 2021). Peer interaction and play behaviour, as perceived by the children themselves, are vital aspects of this social environment. For instance, Howes et al. (1988) examined social development patterns and the sequence of peer engagement. Their findings suggest that stable friendships enhance social skills and that parallel play bridges children's progression from onlooking to cooperative behaviours (Howes & Matheson, 1992; Howes et al., 1992). This implies that a dynamic social environment in ECEC should encourage the evolution of social behaviours. Research further shows that cooperative behaviours foster social skills more effectively than solitary or onlooker behaviours in both play-based assessments (Farmer-Dougan & Kaszuba, 1999) and educational practices (Jin & Moran, 2018). The physical environment underpins the social environment by providing the spatial context for these interactions, as flexible spaces enable cooperative behaviours (Garte, 2020).

In this context, the social and physical environments of ECEC are fundamentally interconnected. From the perspective of children's play behaviours, individuals, peers, and material elements together form the interactive system within preschools, referred to as the social environment of ECEC. Figure 1 illustrates the dynamic relationship between ECEC environmental components and children's characteristics. For children's development and outcomes, the physical and social environments in ECEC are complementary; the physical environment should underpin and support the functioning of this reciprocal system. Although previous studies have demonstrated that certain physical attributes (e.g., adjacency) affect children's performance (e.g., task concentration), it remains unclear which specific spatial components or physical elements in classrooms lead to particular behaviours or actions in children. Does this relationship remain consistent across different kindergarten settings? To address these questions, a more focused approach is essential to guide future empirical studies. The following section adopts an eco-psychological perspective to examine the child-environment relationship.

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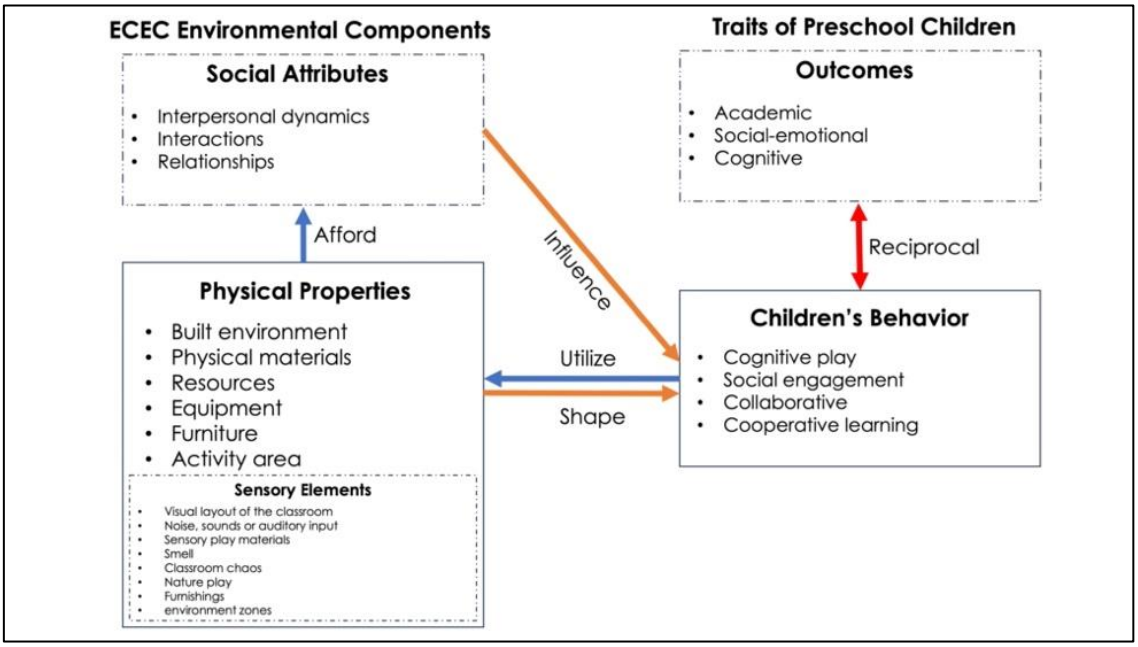

Fig. 1. The Framework of Dynamic Process Between the ECEC Environmental Components and Traits of Children.

Source: Authors (2024)

INVESTIGATING THE CHILD-ENVIRONMENT RELATIONSHIP THROUGH AN ECO-PSYCHOLOGICAL APPROACH

Previous studies have emphasised the significance of the physical environment in ECEC for influencing children's behaviours, competencies, and developmental outcomes (Sando & Sandseter, 2022; van Liempd et al., 2020). However, the majority of empirical research has adopted a quantitative approach (Abbas et al., 2016; Maxwell, 2007), relying on post-evaluation assessments, which often overlook the fluid and interconnected relationship between children and their environments. This gap raises the question of how to consider the ECEC physical environment from a child's perspective. The ecological psychological theory of affordances offers a new perspective. Ecological psychology, pioneered by J. J. Gibson in perceptual research and E. J. Gibson in developmental psychology in the 1950s (Raymond et al., 2017), focuses on perception, cognition, and behaviour, emphasising the interrelationship between organisms and their environments. This theory provides an alternative to traditional cognitivist and behaviourist views, offering a third approach to understanding cognition (Lobo et al., 2018). Unlike environmental psychology, which focuses on the various temporal scales of human-environment interactions (De Groot, 2018; Gifford, 2014; Stokols, 1978), ecological psychology highlights the real-time, ongoing nature of perception and action (Gibson, 1979; Raymond et al., 2017), using the environment-organism system as the unit of analysis and considering affordances as the key object of study (Michaels & Palatinus, 2014). Thus, exploring how spatial components such as furnishings and play materials afford specific actions and behaviours in children is a promising approach to understanding child-environment interactions more deeply.

According to Kyttä's (2003) refinement of Heft's (1988) original stance, affordances can be categorised into two (2) facets. The first is potential affordance, which refers to environmental qualities, while the second is actualised affordance, which emerges from the interaction between individuals and the environment through perception, utilisation, and modification. Potential affordances represent the functional properties offered by the environment and are theoretically limitless (McLaren et al., 2011), as

individuals typically utilise only a subset of the affordances provided by an object (Kyttä, 2003). In other words, potential affordances reflect environmental factors, whereas actualised affordances are influenced by human factors within the organism-environment system. However, in China's current early education context, several influential factors constrain potential affordances, such as teachers' pedagogical philosophies (Li et al., 2019), age-homogeneous classroom strategies (Wu et al., 2022), and specific spatial components within classrooms (Acer et al., 2016; van Liempd et al., 2018).

When children engage with their surroundings in childcare settings, the dynamic process of perception and action is understood as the actualisation of affordances (Kyttä, 2003). In this perception-action loop, children recognise the potential affordances of their environment and transform them into distinct, actualised affordances through use. This process of perceiving, utilising, and modifying the environment constitutes the three (3) levels of actualised affordances (Kyttä, 2003). Children, based on their perspectives, may adapt to the potential functions of certain objects or environments (e.g., using a crayon as a sword), interacting with their surroundings and unconsciously developing social skills and competencies (Huang, 2017; van Liempd et al., 2018).

In summary, environments with fewer restrictions and higher levels of child preference facilitate more actualised affordances, leading to higher-quality, child-friendly environments and a better fit between children and their surroundings (Aziz & Said, 2016; Kyttä, 2003). In this study, actualised affordances are derived from potential affordances. Once children perceive these affordances, they may choose to engage with a portion of them, interacting with peers or the environment. Therefore, this study's framework examines actualised affordances at two (2) levels—those utilised and those modified by children—to explore their relationship with potential classroom affordances. The framework (see Figure 2) is based on the dynamic interaction between ECEC environmental components and children's traits, aiming to assess how environmental features influence children's immediate actions, revealing their real-time perceptions within the Chinese context.

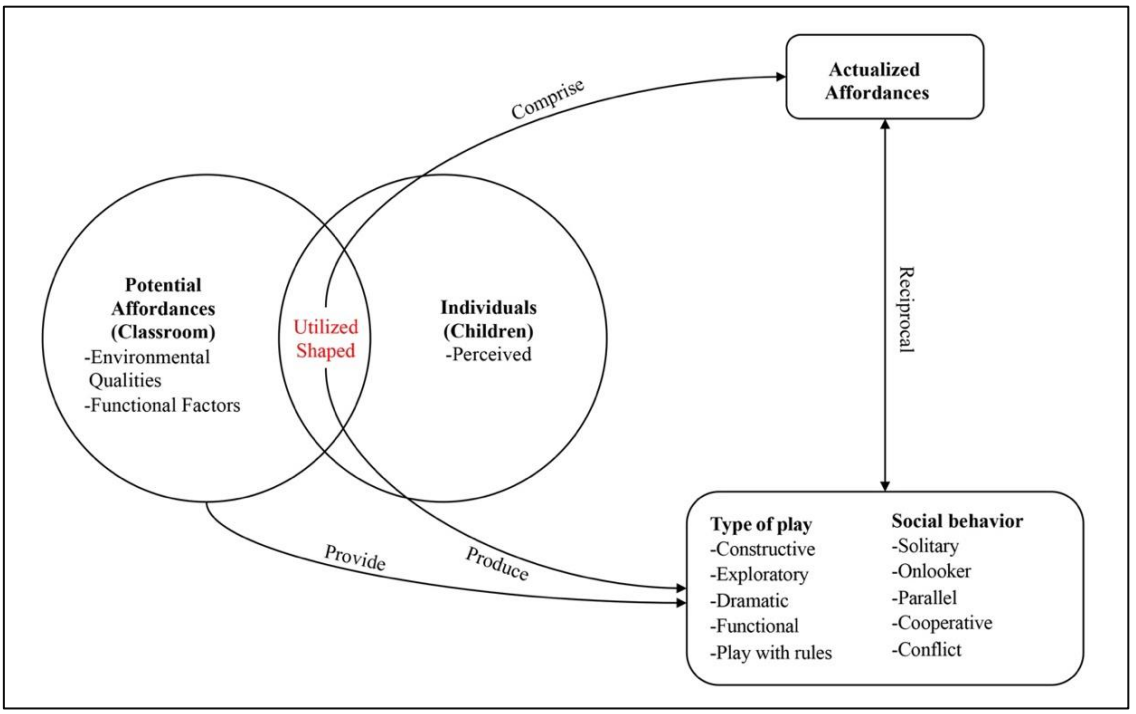

Fig. 2. The Process of Children Perceived, Utilised and Shaped Affordances in which Utilised and Shaped Affordances Comprise the Actualisation of Affordances and Produce Their Play and Social Comportment.

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Source: Authors (2024)

CONCLUSION

The quality of ECEC is intrinsically linked to children's behaviours and developmental outcomes. This review synthesises research on the impact of ECEC's physical environments on children's play and social behaviours, which contribute to their cognitive and social development and competencies. Recent studies on ECEC have largely focused on pedagogical aspects, especially classroom educational quality (Huang & Siraj, 2023; Maier et al., 2022). Consequently, a significant gap remains in the literature regarding the relationship between physical spatial components within ECEC classrooms and children's behaviours and development, particularly concerning how specific spatial elements (e.g., classroom layout) correlate with children's actions. This review also summarises previous findings on the dynamic interactions between ECEC environmental factors and children's characteristics to propose an anticipatory framework based on an eco-psychological approach. Future research should utilise this model to conduct empirical studies, examining how children perceive and engage with the ECEC environment and how these interactions shape their behaviours.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Conceptualisation, Deng Chenhao; Supervision, Nur Maizura Ahmad Noorhani and Arniatul Aiza Mustapha; Writing—original draft, Deng Chenhao; Writing—review & editing, Deng Chenhao and Zhao Zhiyi. All the authors have read and agreed to the published version of the manuscript.

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