Modified Open-Plan Preschool Spaces and Their Influence on Children's Cognitive Development

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Abstract

Modified open-planning to define activity spaces is vital in preschool design. Children's cognitive development is reflected in cognitive school readiness (SR). This study investigates the correlation between modified open-plan spaces and cognitive SR in Malaysian preschools. A prospective cohort study involving 378 children at 18 MOE preschools was conducted. Among all preschool physical design aspects (size, image, scale, circulation, facilities, indoor environment quality, safety, home bases, activity areas, and play yards), the quality of modified open-plan preschool spaces showed the strongest correlation with children cognitive SR (Pearson r=0.658, p=0.000). Findings are hoped to promote better planning in preschool designs.

Keywords: Modified open-plan, cognitive development, preschool design, school readiness

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1.0 Introduction

According to the recent PISA (Programme for International Student Assessment) benchmarking of children cognitive capabilities, Malaysian children remain behind in problem-solving and critical thinking skills compared to their global peers (MOE, 2020; OECD, 2018). Thus, the Malaysian Education Blueprint 2013 – 2025 (MEB 2025) was introduced to address this and ensure that children are afforded better public education facilities to promote better cognitive development in line with international standards. Under MEB 20205, cognitive-oriented syllabus and higher-order thinking skills (HOT) were incorporated into the education system among Malaysian children.

To guarantee children are prepared with the required skills to partake in such an improved syllabus, public preschools in Malaysia were required to ensure children to be cognitively ready for primary school education (MOE, 2020). This recognition and promotion of cognitive school readiness (SR) as an important aspect of childhood education is crucial as it helps establish important developmental foundations desired for children to acquire more complex skills as they progress in life. Studies have established that children with high cognitive SR are better-prepared to perform better in life compared to children with poor cognitive SR (Blair & Raver, 2015; Davies et al., 2020).

Nonetheless for preschools to accommodate these national efforts, classroom settings must initially be conducive to accommodate and provision such pedagogy. In essence, activity and learning spaces should be designed with children’s learning behaviour in mind, as practised in most Western countries (Abbas et al., 2016; Dayaratne, 2016). Modified open-plan spaces enable us the flexibility to support various formal preschool learning activities. By having spaces that are partly enclosed to safeguard children from distractions but allow ample room for highly supervised and administered learning, children’s learning through dramatic and pretend play can flourish (Moore, 2012). Furthermore, such classroom settings strengthen classical and operant conditioning in children to boost their attainment of cognitive abilities during classroom learning.

Notwithstanding many studies advocating the suitability of such planning in preschool design, the important role of modified open-plan preschool spaces remains overlooked in Malaysia – most public preschools adopt open-planned classrooms with little effort to define space for specific activities (quiet, messy and physical) (Abbas, 2016; Mohidin et al., 2015). Occasionally, some elements of modified open-plan spaces are seen in public Malaysian preschools, but their use is often minimal (Figure 1). A lack of awareness of the importance of spatial planning in preschool design is suspected, as evident in the lack of emphasis seen in MEB 2025 (MOE, 2020; Shaari et al., 2020).

2.0 Literature Review

In the design of preschool activity spaces for children, the suitable placement of partial enclosures or furniture can be done to define or ‘modify’ an otherwise open classroom layout (Figure 1). Many studies have suggested that this approach is effective to harness the benefits of both open and closed planning. For children education, these modified open-plans are particularly beneficial as they enable designers to create cosy spaces to reinforce learning but are not too small to overwhelm the child (Moore, 2012). As children learning activities are often dynamic in nature, preschool classroom environments must also be equally adept to accommodate these contrasting daily activities. Indeed, the extensive work done by Moore (2012) and others (Dayaratne, 2016) advocates the importance of having pockets of home-like spaces in classrooms. This is to encourage children's explorative behaviour and promote unobstructed teacher-children interaction while allowing easy access to other activity areas – a unique advantage of adopting modified open-planning in classroom design.

Fig 1. Illustrations of open-plan (left) and modified open-plan preschool spaces (centre, right) in Malaysian MOE preschools
(Source: Author)

The importance of cognitive development and subsequent cognitive SR in early childhood is well-known and established across the world - the UNICEF clearly advocates cognitive SR as a means to ensure a brighter future for children, especially in poor communities where access to high-quality education is limited. For preschool children, cognitive development is primarily reflected in their level of cognitive SR. Cognitive SR can be measured in terms of various aspects of cognitive abilities namely reading, counting, colour appreciation, comparative, and problem-solving skills (UNICEF, 2017). Concerning Malaysia and under the MEB 2025, the abovementioned skills comprise the basis of many aspects of the preschool curriculum and thus are vital milestones for preschoolers to achieve before they enter primary school (MOE, 2020). Moreover, studies continue to show that cognitive proficiencies also contribute to other aspects of development namely physical, motor, and emotional capabilities – further underscoring its importance in childhood development (Raghubar & Barnes, 2017; Bracken, 2007).

Piaget's Theory of Cognitive Development and the constructivist-interactionist approach to cognitive development have long been prevalent references in children's developmental psychology and is frequently adopted in Western institutions to encourage appropriate preschool designs that maximize children learning and cognitive development (Schultz & Schultz, 2016). Piaget's theory states that the preschool physical environment is a vital source of stimuli to encourage positive cognitive development (Moore, 2012). Hence, many aspects of the preschool physical environment design namely size, image, circulation, common shared facilities, safety, spatial planning of activity spaces, and location have the potential to influence the effectiveness of pedagogy on children.

Adopting the principles of Piaget's Theory of Cognitive Development in building design, preschools must be designed to reinforce positive learning experiences and minimize negative ones for proper children's cognitive development to occur. Further, in the absence of a properly-designed preschool physical environment, other elements of the preschool system cannot function properly. For instance, a well-devised curriculum cannot be delivered correctly without a conducive classroom, and so forth.

It was previously reported that the quality of preschool physical environment design was positively associated with children's cognitive SR (Shaari et al., 2020). However, the reasons to explain this relationship remains to be explored. Thus, the current study aims to investigate the relationship between the quality of modified open-plan spaces and cognitive SR among Malaysian preschoolers. Specifically, our objective is to establish the degree of correlation between these two aspects in the hope to shed more light on understanding children's cognitive development in the Malaysian preschool context.

3.0 Methodology

3.1 Study Aims and Objectives

This study aims to examine the relationship between the quality of modified open-plan spaces and cognitive SR in the public Ministry of Education (MOE) preschools in Klang Valley, Malaysia. The objectives are to evaluate the quality of modified open-plan preschool spaces and children's cognitive SR among MOE preschools in Klang Valley, Malaysia and to establish the degree and strength of correlation between these two aspects.

3.2 Study Design

The foundation for this study is the Piagetian approach to preschool design and children's cognitive development. Thus, the assessment tools adopted in this study to assess the quality of modified open-plan spaces and cognitive SR should be based on this. The Children Physical Environment Rating Scale 5 (CPERS5) is a well-known assessment tool developed specifically to assess preschool physical environment quality against the Piagetian approach, thus, is deemed appropriate for this study (Moore, 2012). Furthermore, the CPERS5 tool also measures the quality of modified open-plan spaces along with other physical aspects of preschool design, permitting us to conduct comparative studies. Similarly, the Bracken School Readiness Assessment-3 (BSRA-3) tool measures preschool children's cognitive readiness to enter primary school to reflect their level of cognitive development, thus was chosen to evaluate cognitive SR and subsequent cognitive development (Bracken, 2007).

In this study, MOE preschools were selected because they cater for the broadest range of socio-demographic backgrounds compared to other public preschools (KEMAS, PERPADUAN, and PERMATA) and Klang Valley was chosen as the region with the most well-adjusted demographic distribution in Malaysia. Moreover, MOE preschools will be the main public preschool in Malaysia by 2025, hence, assessment of MOE preschools would further highlight the importance of this study (MOE, 2020). Purpose-built MOE preschools from the year 2002 that only cater to six-year-old children were selected to ensure that participants were exposed to the same syllabus, teaching, and social environment throughout the study. Based on these criteria, 18 MOE preschools were shortlisted.

800 six-year-old MOE preschool children were registered in Klang Valley. A minimum of 363 children (20.17 per selected preschool) was needed to represent this population with 99% confidence. Thus, a total of 21 preschoolers were randomly selected from each preschool to standardise the number of participants per school, giving a final total of 378 children.

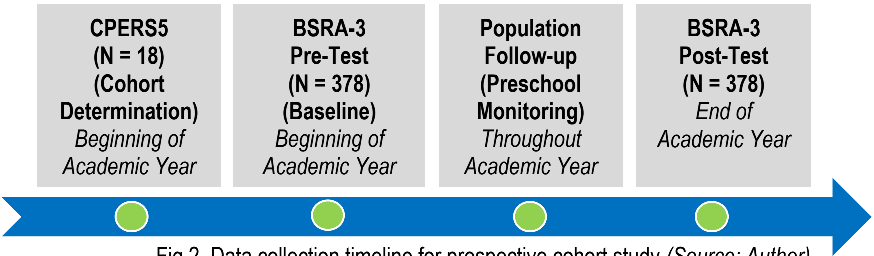

Fig 2. Data collection timeline for prospective cohort study *(Source: Author)*

Taken together, to examine the association between the quality of modified open-plan spaces and children's cognitive SR, an observational prospective cohort study involving 18 MOE preschools in Klang Valley and 378 six-year-old preschoolers were conducted (Figure 2). This method allows the study to prospectively observe behavioural changes in children at a particular setting over a consistent time; with minimal interference on both the preschool and preschool children. Per cohort study methods, the study begins with CPERS5 assessment to define each cohort. Cognitive SR of each preschooler at the beginning and end of the academic year were then measured with BSRA-3 Pre-Test and Post-Test, respectively. All preschools were followed-up during the study to ensure that each cohort remained consistent and that no modifications were made to the preschool environment. To prepare data for correlation analysis, the BSRA-3 Final Score for each preschooler is attained with the formula below:

BSRA-3 Final Score = BSRA-3 Post-Test - BSRA-3 Pre-Test (1)

The BSRA-3 Final Score reflects the change in cognitive SR of a child whilst attending a particular preschool (cohort). Since the study is concerned with the improvements/decline in cognitive SR of preschoolers who attend each public MOE preschool, the BSRA-3 Final Score is crucial as it constitutes the dependent variable of interest for this study.

Finally, Pearson's correlation analysis was then conducted to look at the degree and strength of association between the quality of modified open-plan spaces (CPERS5 score) and cognitive SR (BSRA-3 Final Score). For comparison, Pearson's correlation analyses were also done on all other preschool aspects assessed in the CPERS5 tool.

3.3 Study Variables

The independent variable for this study is the quality of modified open-plan preschool spaces. Other independent variables include other physical aspects of preschool design as outlined in the CPERS5 tool. These include centre size, image, scale, circulation, common shared facilities, indoor environment quality (IEQ), safety, home bases, activity areas, and play yards. The dependent variable is the variation in the level of cognitive SR among preschoolers, reflected in BSRA-3 Final Scores. The change in cognitive SR shows the level of children's cognitive development.

3.4 Study Limitations

The limitation of this study is ascribed to preschools with the abovementioned criteria. Therefore, this study could not be generalised to other public preschool types. Although best efforts have been made to maintain consistency of assessment, biasness may be present in the evaluation process.

3.5 Study Procedure 1: Consenting

Upon obtaining approval from the related authorities, floor plans for all preschool buildings were requested from the principals of all participating preschools. However, the research team prepared measured drawings of all preschools without floor plan drawings before the assessments for cross-reference. For a better recording of details for each participating preschool, preschool background information inventories were distributed for preschool teachers to complete. All teachers were invited to fill in the information form with particulars such as preschool name, address, name of the principal, contact details, current enrolment, built year, and purpose of the building. The forms were reverted and collected towards the end of the study period.

3.6 Study Procedure 2: Pilot Study

Initially, the study begins with a pilot assessment before the actual field study to establish familiarity with the proposed instrument – the CPERS tool, and its assessment procedure. It was also done to foresee and address any possible issues with the proposed tool and method before commencing the actual field study.

3.7 Study Procedure 3: Data Collection (Field Study)

All the 26 selected preschool buildings were individually surveyed and assessed using the CPERS tool. Each preschool was scored according to the existence of particular items as stipulated in the CPERS guidelines, and how well the quality of the individual elements was. The period of evaluation for each preschool varied between 2 and 4 hours depending on the readiness of floor plans before the field study, size, and complexity of the preschool buildings.

3.8 Study Procedure 4: Data Analysis

Descriptive analyses were made on CPERS5 data and the mean for all subscales was categorised based on CPERS5 guidelines (Poor, Fair, Good, and Excellent). Normality tests (Shapiro-Wilk, Z-Skewness, and Z-Kurtosis), reliability test (Cronbach's α), and 2-tailed significance T-test were done on all CPERS5 and BSRA-3 data. After normality is established for each data set, Pearson correlation analysis was done to evaluate the relationship between all aspects of CPERS5 and BSRA-3 Final Score. The strength of correlation was concluded using Guildford's Rule of Thumb ($r < 0.2$ = no correlation, $r > 0.2$ = weak, $r > 0.4$ = moderate, $r > 0.7$ = strong) (Field, 2017). Finally, aspects with the strongest correlation category with cognitive SR were plotted to visualise their scatter distribution. All statistical analyses were done using the SPSS software (version 25).

4.0 Study Results

4.1 Descriptive Analysis and Reliability Testing of CPERS5 and BSRA-3 Final Scores

Table 1. Descriptive Analysis of CPERS5 (Subscales 1 – 14) and BSRA-3 Final Scores

Item	N	Min.	Max.	Mean	SD	Descriptive Category
CPERS5 Subscale 1 (Centre Size & Modules)	18	0.250	2.670	1.376	0.688	Fair
CPERS5 Subscale 2 (Image & Scale)	18	2.165	3.050	2.420	0.280	Good
CPERS5 Subscale 3 (Circulation)	18	0.500	2.830	2.007	0.717	Good
CPERS5 Subscale 4 (Common Shared Facilities)	18	1.180	2.000	1.501	0.255	Fair
CPERS5 Subscale 5 (Indoor Environment Quality)	18	1.575	2.570	2.000	0.351	Fair
CPERS5 Subscale 6 (Safety & Security)	18	1.250	3.050	2.310	0.550	Good
CPERS5 Subscale 7 (Modified Open-Plan Spaces)	18	0.500	3.000	1.938	0.729	Fair
CPERS5 Subscale 8 (Home Base)	18	2.165	2.670	2.420	0.152	Good
CPERS5 Subscale 9 (Quiet Activity Areas)	18	0.500	3.000	1.709	0.700	Fair
CPERS5 Subscale 10 (Physical Activity Areas)	18	0.000	1.800	0.815	0.495	Poor
CPERS5 Subscale 11 (Messy Activity Areas)	18	0.650	1.600	0.964	0.290	Poor
CPERS5 Subscale 12 (Play Yards – Functional)	18	1.570	3.150	2.325	0.423	Good
CPERS5 Subscale 13 (Play Yards – Developmental)	18	0.385	2.255	1.215	0.454	Fair
CPERS5 Subscale 14 (Location & Site)	18	2.275	3.360	2.890	0.368	Good
BSRA-3 Final Score	378	-20	55	9.670	14.23	Fairly Ready

*CPERS5 score rating: - Poor (0.000 – 1.000), Fair (1.001 – 2.000), Good (2.001 – 3.000), Excellent (3.001 – 4.000) *(Source: Author)*

Table 2. Normality of CPERS5 (Subscales 1 – 14) and BSRA-3 Final Scores

Item	N	Shapiro-Wilk	Z-Skewness	Z-Kurtosis	Normal
CPERS5 Subscale 1 (Centre Size & Modules)	18	0.103	-0.202	-1.077	Yes
CPERS5 Subscale 2 (Image & Scale)	18	0.177	0.789	-0.646	Yes
CPERS5 Subscale 3 (Circulation)	18	0.709	-0.884	0.444	Yes
CPERS5 Subscale 4 (Common Shared Facilities)	18	0.209	1.336	-0.232	Yes
CPERS5 Subscale 5 (Indoor Environment Quality)	18	0.199	0.307	-0.905	Yes
CPERS5 Subscale 6 (Safety & Security)	18	0.155	-0.659	-0.772	Yes
CPERS5 Subscale 7 (Modified Open-Plan Spaces)	18	0.128	-0.739	-1.338	Yes
CPERS5 Subscale 8 (Home Base)	18	0.069	0.099	-0.661	Yes
CPERS5 Subscale 9 (Quiet Activity Areas)	18	0.100	1.609	0.331	Yes
CPERS5 Subscale 10 (Physical Activity Areas)	18	0.464	0.605	-0.351	Yes
CPERS5 Subscale 11 (Messy Activity Areas)	18	0.159	1.053	0.656	Yes
CPERS5 Subscale 12 (Play Yards – Functional)	18	0.688	0.449	0.114	Yes
CPERS5 Subscale 13 (Play Yards – Developmental)	18	0.773	0.559	0.567	Yes
CPERS5 Subscale 14 (Location & Site)	18	0.156	-0.437	-1.063	Yes
BSRA-3 Final Score	378	0.099	-0.151	-0.149	Yes

*Normal distribution if Shapiro-Wilk (p) > 0.05, -0.863 < Z-Skewness < 1.700, and -1.263 < Z-Kurtosis < 0.896 *(Source: Author)*

Table 3. Reliability of CPERS5 (Subscales 1 – 14) Scores (N=18)

Item	Cronbach's α If Item Deleted	Cronbach's α
CPERS5 Subscale 1 (Centre Size & Modules)	0.801	0.833
CPERS5 Subscale 2 (Image & Scale)	0.702	
CPERS5 Subscale 3 (Circulation)	0.706	
CPERS5 Subscale 4 (Common Shared Facilities)	0.780	
CPERS5 Subscale 5 (Indoor Environment Quality)	0.708	
CPERS5 Subscale 6 (Safety & Security)	0.761	
CPERS5 Subscale 7 (Modified Open-Plan Spaces)	0.743	
CPERS5 Subscale 8 (Home Base)	0.716	
CPERS5 Subscale 9 (Quiet Activity Areas)	0.715	
CPERS5 Subscale 10 (Physical Activity Areas)	0.762	
CPERS5 Subscale 11 (Messy Activity Areas)	0.812	
CPERS5 Subscale 12 (Play Yards – Functional)	0.816	
CPERS5 Subscale 13 (Play Yards – Developmental)	0.799	
CPERS5 Subscale 14 (Location & Site)	0.746	
CPERS5 Total Score	0.701	

*Reliable if Cronbach's α if item deleted < Cronbach's α and > 0.7 *(Source: Author)*

Table 4. Reliability of BSRA-3 Final Scores (N=378)

Item	Cronbach's α If Item Deleted	Cronbach's α
BSRA-3 Subtest 1	0.701	0.790
BSRA-3 Subtest 2	0.702	
BSRA-3 Subtest 3	0.751	
BSRA-3 Subtest 4	0.709	
BSRA-3 Subtest 5	0.735	
BSRA-3 Total Score	0.764	

(Source: Author)

4.2 Pearson's Correlation Analysis of CPERS5 and BSRA-3 Final Score Results

Table 5. Correlation between CPERS5 (Subscales 1 – 14) and BSRA-3 Final Score (N=378)

Item	BSRA-3 Final Score		Strength of Correlation
	Pearson's r-c	Sig. 2-tailed (p)	
CPERS5 Subscale 1 (Centre Size & Modules)	0.425	0.000	Moderate
CPERS5 Subscale 2 (Image & Scale)	-0.050	0.337	-
CPERS5 Subscale 3 (Circulation)	0.474	0.000	Moderate
CPERS5 Subscale 4 (Common Shared Facilities)	0.268	0.000	Weak
CPERS5 Subscale 5 (Indoor Environment Quality)	0.219	0.001	Weak
CPERS5 Subscale 6 (Safety & Security)	0.210	0.001	Weak
CPERS5 Subscale 7 (Modified Open-Plan Spaces)	0.658	0.000	Moderate
CPERS5 Subscale 8 (Home Base)	0.030	0.558	-
CPERS5 Subscale 9 (Quiet Activity Areas)	0.416	0.000	Moderate
CPERS5 Subscale 10 (Physical Activity Areas)	0.219	0.001	Weak
CPERS5 Subscale 11 (Messy Activity Areas)	0.309	0.000	Weak
CPERS5 Subscale 12 (Play Yards – Functional)	0.045	0.378	-
CPERS5 Subscale 13 (Play Yards – Developmental)	-0.088	0.089	-
CPERS5 Subscale 14 (Location & Site)	0.054	0.294	-

* r < 0.2 = no correlation, r > 0.2 = weak, r > 0.4 = moderate, r > 0.7 = strong *(Source: Author)*

4.3 Scatter Distribution of Items with Strongest Pearson's Correlation Coefficient (r)

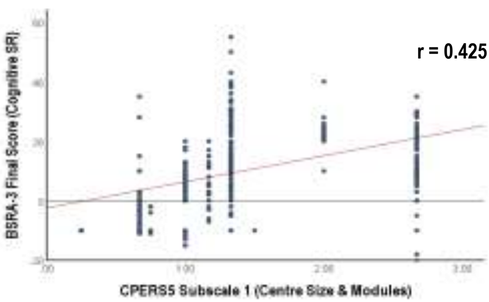

Fig 3. CPERS5 Subscale 1 (Centre Size & Modules) & BSRA-3 Final Score (N = 378)
(Source: Author)

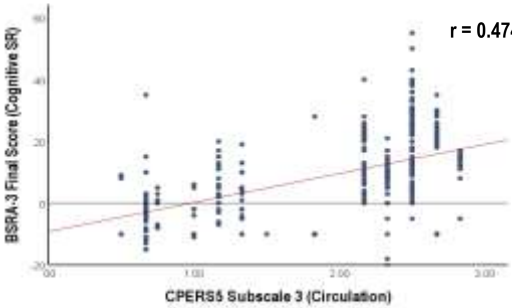

Fig 4. CPERS5 Subscale 3 (Circulation) & BSRA-3 Final Score (N = 378)
(Source: Author)

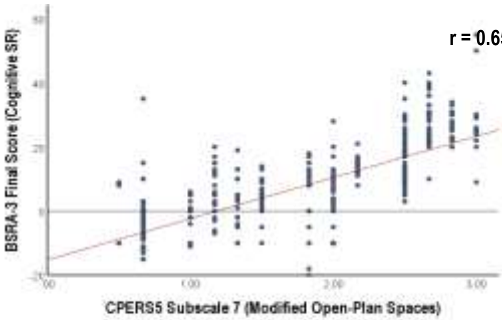

Fig 5. CPERS5 Subscale 7 (Modified Open-Plan Spaces) & BSRA-3 Final Score (N = 378)
(Source: Author)

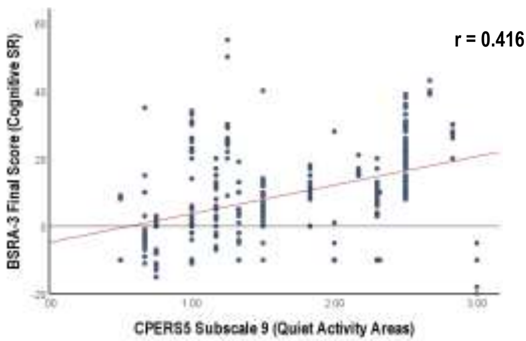

Fig 6. CPERS5 Subscale 9 (Quiet Activity Areas) & BSRA-3 Final Score (N = 378)
(Source: Author)

5.0 Discussions

5.1 Descriptive Analysis and Reliability Testing of CPERS5 and BSRA-3 Final Scores

As shown in Table 1, no MOE preschool achieved an 'Excellent' rating for any physical environment aspect. On BSRA-3 Final Score, the average MOE preschooler was only found to be 'Fairly Ready' for a primary school in terms of cognitive SR. Based on the guideline for standard BSRA-3 assessment procedures, preschool children must be at least 'Very Ready' to safeguard a continuous transition into primary school (Bracken, 2007). Based on the data shown, as the most relatable preschool physical aspect for learning activities, the quality of activity spaces (quiet, physical, messy) in public MOE preschools is concerning. As seen, none were 'Good' nor 'Excellent'. Since pretend and explorative play also constitutes an important share of children's learning, the fact that physical and messy activity areas were 'Poor' can be disadvantageous to their learning and development in preschools. However, this is unsurprising as vital aspects that impact spatial design namely size and planning (modified open-plan spaces) were only found to be 'Fair'. This agrees with findings made in previous studies (Moore, 2012). It underscores the importance of preschool size and modified open-plan spaces to guarantee sufficient space and conducive learning spaces, respectively.

As for preschool physical environment aspects that were rated as 'Good', we can infer that image, safety, as well as security and site location, indeed profited from MOE preschools being annexed inside primary school compounds. This aspect of MOE preschool design in Malaysia is praiseworthy and should be advocated for other public preschool designs. Being within the primary school compounds enable MOE preschools to share as well as take advantage of amenities and features that are available in much more established institutions namely security and safety, whereby preschool buildings are often within the line of sight of other working adults during school time to ensure security at times of emergency. Besides, in terms of location, MOE preschools are often located in desired areas far away from hazardous elements such as road traffic at main roads and high-tension power cables. Nevertheless, these preliminary findings confirm our concern that Malaysian public preschools are lacking in most aspects of preschool physical environment design. As such, more enhancements are needed to confirm better quality among all aspects of the preschool building concerning children's learning and cognitive development.

For normality determination of the obtained data, Table 2 allows us to deduce that all data are normally distributed and suitable for parametric assessments. Shapiro-Wilk, Z-kurtosis, and Z-Skewness values were all within normal ranges, as per Field (2017).

The reliability testing of CPERS5 data shown in Table 3 showed a Cronbach's Alpha (α) of 0.833. Cronbach's Alpha (α) for each subscale if items were deleted ranged between 0.701 and 0.816, which is lower than 0.833 – indicating data are reliable. Similarly, BSRA-3 Final Score exhibited Cronbach's Alpha (α) of 0.790, with Cronbach's Alpha (α) for each subtest if deleted ranging between 0.701 and 0.764, which is lower than 0.790 (Table 4).

This indicates that the collected CPERS5 and BSRA-3 data are highly reliable to represent the studied population (Field, 2017).

5.2 Association of Preschool Physical Environment Aspects With Cognitive SR

As with all preschool designs, given that different preschool physical environment aspects are proposed for different functions, we foresee varying degrees of correlation between CPERS5 subscales and BSRA-3 Final Score (Shaari et al., 2020). As predicted, from Table 5 it can be seen that not all preschool physical environment design aspects were associated with cognitive SR (BSRA-3 Final Score).

Firstly, Subscales 4 (Common Core of Shared Facilities), 5 (Indoor Environment Quality), 6 (Safety and Security), 10 (Physical Activity Areas), and 11 (Messy Activity Areas) established a weak correlation with the BSRA-3 Final Score. This suggests that these aspects do not affect cognitive SR directly, but indirectly - perhaps in combination or synergy with one another. For example, aspects such as the common core of shared facilities, indoor environment quality, and safety mainly function to provide comfort for both teachers and students but do not affect learning activities directly. Hence, they are only weakly correlated with cognitive SR, as shown in Table 5. Moreover, physical and messy activity areas accommodate physical as well as art and craft activities. Explaining why they are also only weakly associated with cognitive SR. This highlights the different role of preschool physical environment aspects of children learning and cognitive development and is consistent with Piaget's Theory of Cognitive Development.

Equally, quiet activity areas (subscale 9) exhibited a moderate association with cognitive SR. Since this activity area is mainly intended for reading and learning, it should be more associated with cognitive development, as seen from our data. This corroborates data from other studies namely Moore (2012). Furthermore, additional significant features of preschool design such as size (Subscale 1), circulation (Subscale 3), and modified open-plan spaces (Subscale 7) were moderately associated with cognitive SR. Given the importance of size, modified open-planning and quality of circulation in indoor preschool spaces in creating a conducive learning environment for preschoolers, these aspects are expected to impact children's cognitive SR more strongly. Reinforcement of learning processes can be maximised with these aspects as the core of the preschool design.

But although public MOE preschools mostly adopt open-planned spaces which would result in better circulation, the poorer quality of modified open-plan spaces due to a large and open central space and the adoption of some elements of modified open-plan spaces (Figure 1) benefited from this to a certain extent, albeit not as much as expected because modified open-plan spaces (Subscale 7) was only rated Fair (Table 1). From the perspective of the preschool children, there must be a balance between designing suitable circulation and spatial planning in preschool environments as they can affect spaces being too big and overwhelming. This can be counter-productive as it is against reinforcing cognitive development among children – further negating the design of preschool learning spaces.

5.3 Modified Open-Plan Spaces Exhibited Strongest Correlation with Cognitive SR

Among all preschool physical environment design aspects, the quality of modified open-plan spaces demonstrated the highest association with cognitive SR (r = 0.658, p = 0.000). This goes to validate our proposition that the quality of modified open-plan spaces plays an essential role in cognitive development and cognitive SR among Malaysian MOE preschoolers.

To further understand and envision the correlation data presented in this study, correlation scatter plots were illustrated (Subsection 4.3). As shown, we see that modified open-plan spaces (Figure 5) demonstrated the best goodness-of-fit line (marked red) compared to other aspects (Figures 3, 4 and 6). This again supports our proposition on the strength of association with cognitive SR, compared to other aspects of the preschool physical environment.

Moreover, from the scatter plots we can also deduce that for modified open-plan spaces when scores are above 2.00 (Good & Excellent), no negative BSRA-3 Final Score data were seen. This means that no reduction in cognitive SR was observed when a particular physical aspect was at least rated as Good. This also suggests that when the quality of modified open-plan spaces was Good, an improvement in cognitive SR was seen in all assessed preschool children. Interestingly, this was not seen in other aspects, as shown in Figures 3, 4, and 5. This is noteworthy as it suggests the importance of adopting high quality modified open-plan spaces in preschools. The existence of preschools with an 'Excellent' rating for modified open-plan spaces would enable us to further argue and conclude this proposition.

There are several potential reasons why modified open-plan spaces demonstrated the strongest correlation with children's cognitive SR. Given that appropriate spatial planning is crucial for the correct allocation of space for daily preschool learning activities, the quality of modified open-planned spaces therefore directly affects the preschool's capacity to serve its main purpose which is to ensure cognitive development and subsequent cognitive SR.

Moreover, spatial planning is also important for the correct design of other secondary preschool spaces such as the common core of shared facilities and home bases which do not affect cognitive SR directly but do so indirectly. For instance, preschoolers would surely feel more at home if home bases and the shared facilities are sufficient. This then would affect their motivation to learn, indirectly affecting their grasp of cognitive abilities thought in school (Moore, 2012). Taken together, this underscores the importance of modified open-plan spaces in the design of preschool learning environments. Without appropriate planning of spaces that are crucial for learning, preschool education cannot be maximised. Worse, the poor planning of preschool spaces could be detrimental to children's learning and cognitive development (Dayaratne, 2016).

6.0 Conclusion & Recommendations

Findings from this study show that the quality of modified open-plan preschool spaces demonstrated the strongest correlation with cognitive SR among Malaysian MOE preschools. Given that the quality of modified open-plan spaces was only found to be rated as 'Fair', more importance should be given to the suitability of spatial planning in preschool learning areas to accommodate children's play and learning behaviour. Furthermore, as it was also found that Malaysian preschoolers were only fairly ready for primary school, there is an urgent need for more attention to be given to the quality of spatial planning as it would greatly impact the quality of activity spaces and subsequent cognitive SR. The current status of the quality of preschool physical environment design in public MOE preschools explains why Malaysia's public preschool efforts under MEB 2025 were inadequate to improve Malaysia's PISA performance. With the benefits modified open-plan spaces have to offer in maximising and reinforcing positive stimuli to encourage children learning, designers should tailor their ideas to incorporate more cosy 'pockets of activity spaces' within preschool classrooms. The use of partial partitioning in preschool learning spaces could be an excellent way to achieve this. Further, with the child's perspective as the main aspect to take into account during preschool design processes, such a shift in design principle could go a long way to ensure Malaysian children are afforded better learning facilities to boost their cognitive development as they progress in life. Ultimately, it is hoped that the quality of preschool physical environment design in Malaysian preschools does not continue to be overlooked and that this study could help to elicit more awareness on the importance of modified open-planning in childhood education to ensure more conducive preschool environments.

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Paper Contribution to Related Field of Study

Given the lack of understanding of the importance of spatial planning in the design of preschools, this study is important. It furthers the understanding of the impact of spatial planning, particularly modified open-plan spaces, on cognitive development and subsequent cognitive SR of preschool children in MOE preschools in Malaysia. This constitutes an important effort to guarantee better education for the future generation in Malaysia.

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