COMPARATIVE STUDY ON LIGHTING AND VENTILATION OF TWO KINDERGARTEN TYPOLOGIES IN SELANGOR

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Abstract
This paper aims to investigate the spatial quality in kindergartens by comparing two different kindergarten typologies based on lighting and ventilation as design factors. Most kindergartens in Malaysia are converted from either a house or a shop lot that were not purposely built to suit the functions of a good learning environment. This has caused restrictions on space planning and affects the learning quality of the children. Past works have shown studies on space effectiveness in terms of safety, security and comfort level based on user perception, however, there were no research done on spatial quality of kindergartens with regards to lighting and ventilation as design factors. This research is important as it justifies and suggests the better type of building that can be converted into a kindergarten to provide better learning environment for the children from the two most popular type in Selangor ; dwelling-type and shop lot-type kindergarten. A case study method is utilized to analyze these two different types of kindergarten in Selangor by focusing on the design factors mentioned above. The findings will provide a comprehensive data that can be used as a basis for future research in the field of learning environment and as a reference in preparing kindergarten set up requirements in the future in order to achieve the best design approach in designing the effective learning environment in kindergartens.

Keywords: Design factors; lighting and ventilation, kindergarten typologies; dwelling kindergarten, shop lot kindergarten.

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INTRODUCTION

The awareness on the importance of early childhood education has increased tremendously in Malaysia. According to the Malaysian Education Blueprint 2013-2025, it is made compulsory for pre-school children to complete their study before entering the primary education level. Hence, the need for kindergartens in Malaysia is seen crucial in the country's development (Ministry of education Malaysia, 2013). It is often said that "a good kindergarten is the third teacher for the children" and kindergarten environment is essential for these children because it is the place where they start to develop their emotional, social relationship, and their physical skills (Kotnik, 2017).

Early childhood care and education (ECCE) in Malaysia has divided children into two age groups; 0-4 years old and 4-6 years old (Foong, 2018; Mustafa et al., 2014). The 4-6 years old category is considered as pre-school level and it will be the focus of this study. In 2003, the Ministry of Education (MOE) has set up the National Preschool Curriculum guide which is required to be followed upon setting up a kindergarten by public and private kindergarten operators (Ministry of Education, 2019; Kamarulzaman Kamaruddin, 2017). The guide aims to ensure that the children are able to develop the five main skills throughout the pre-school study which are the social skill, intellectual skill, physical skill, spiritual skills and aesthetic value (Ministry of Education, 2019; Kamarulzaman Kamaruddin, 2017). Kotnik (2017) highlighted that good indoor space design in a kindergarten would be able to provide better education that supports the development of children. Unfortunately, most of the Kindergarten in Malaysia were not build to fit to this purpose as most of the kindergartens operated in premises that have been fully refurnished from dwelling and shop lot units (Salleh N. , 2013). Kindergartens have played a vital role in early childhood development among children in recent years due to rising demand from parents in which majority are mothers (70%) who was working full time in Malaysia and depended on kindergarten teachers to help and provide the required knowledge for their children (Mustapha, 2016). Poor building design that create poor environment in a kindergarten will affect and degrade student performance (Salleh N. , 2013). Therefore, it is crucial to identify the current spatial condition in kindergartens which are resulted from the conversion of existing buildings into kindergartens.

The purpose of this study is to discover the optimum space quality in kindergarten classrooms and playground by comparing two types of kindergarten in Selangor, namely kindergartens that are either converted from a house or a shop lot building, by looking at two main factors which are lighting and ventilation. The objectives of the study are: i) to identify the factors that affect the space quality in

kindergarten, ii) to analyse the learning experience of children in the Kindergarten by analysing through the main factors in space quality, and iii) discover the choice of building typologies to be converted into kindergarten by comparing two different typologies Kindergarten through the analysis of main factors in space quality. The study is important as it aims to highlight the effects of building conversion towards the kindergarten learning environment.

CHILDREN AND ARCHITECTURE

Since children are part of a growing community that one day will be the backbone of the country, it is worthwhile to discuss the stages of intellectual development of children in order to provide better quality education through good quality space planning and architecture in the following sections;

Development stage of Children

It is crucial to understand the development stages of children before the discussion to get an overall picture on the focus group for the study. The theory that has been selected for the study was Piaget's Theory of Intellectual Development for a child by Jean Piaget, most influences researches in the field of developmental psychology during the 20th century. Jean Piaget classified children development into four main stages as listed below. (B.Adamson, 2018)

a. Sensorimotor stage (Infancy)
b. Pre-operational stage (Early Childhood)
c. Concrete operational stage (Early adolescence)
d. Formal operational stage (Adulthood)

Figure 1: Stages in Piaget's Theory of Intellectual Development

For this research study, the focus will be on children in stage 2, the Pre-operational stage (Early Childhood). Stage 2 involved 2 to 7 years old children and the children under this stage started to develop their language skills and they have the ability to link up the words and symbols with the objects they saw and curious about things that happen around them (B.Adamson, 2018). Hence, the learning environment is important because they learn through their experience of their surroundings.

Type of kindergarten in Peninsular Malaysia

According to the guideline provided by the Department of Town And Country Planning *(Jabatan Perancangan Bandar dan Desa, 2017)*, there are four main typologies to which a kindergarten can be built, they are:

Category 1 – Built on a site that has an existing building
Category 2 – Built on an vacant site (usually meant for institutional purposes)
Category 3 – Converted from an office building, an institutional building or a multi-storey commercial building
Category 4 –Built in a housing area

Based on this data, there are overlaps between these categories. For example, a kindergarten operator could get approval from the local authority to set up a pre-school in an existing property in a housing area. Most of the time the kindergarten operators will have to check and seek advice from the Local Planning Authority (Jabatan Perancangan Bandar dan Desa, 2017).

Due to the constraints in the urban context where land are scarce and cost of property is very high, most of the private kindergarten operators have opted to use existing buildings as a kindergarten, be it on a dwelling typology or a commercial typology (Mustafa et al., 2014).

Quality learning spaces in kindergarten

The quality of indoor environment created in the Kindergarten is equally important compared to the form of the building because children appreciate architecture through the space experience in the Kindergarten (Kotnik, 2017; Virtual Lab School VLS, 2013). Space, physical contact, and physical activity are interrelated. Children experience the spaces in kindergarten by using their bodies, senses, relations position and actions (Nordtomme, 2012). According to Feresin (2017), a quality learning space in kindergarten shall be able allow children to learn new knowledge, skill, to discover and express creativity which will improve their life skills (Feresin, 2017).

The physical learning environment for children in a kindergarten

Most of the resources with regards to kindergarten in Malaysia have emphasised on the teaching quality of the teachers and the scope of curriculum provided while guidance on the physical learning environment in kindergarten is seen still lacking. This is crucial as children in kindergarten age are more sensitive toward space and they are capable to analyse and distinguish the reality through their sensory receptors (Feresin, 2017). A successful kindergarten environment design shall be able to fulfil the needs and interest of the children where it can be achieved by having a good physical learning environment (Shaari M.F., 2018). Hence, the research will focus on the physical learning environment aspect in the kindergarten and it can be divided into four main categories as listed in figure 3.

Figure 2: Physical learning environment for children. (Adapted from Shaari M.F., 2018)

The government's strategies to improve the quality of preschool education could be seen clearly in the Preschool Education Policy & National Key Result Area (NKRA) (Ministry of Communication and Multimedia, 2013). However, most policies are designed to improve teaching systems and social environments, with minimal allocation to physical environment.

The human comfort level in the physical learning environment will affect children behaviour and the learning process (Shaari M.F., 2018). The study will be focusing on category 2 and 3 due insufficient research data and it is more related to the research aim of this research that is to analyse the physical learning space quality in different kindergarten typologies. Category 1 was not selected because it is understood to be inclined towards architectural building design in a building built meant to function as a kindergarten while category 4 is inclined towards the academic program and syllabus in the kindergarten. Hence, both categories 1 and 4 were not suitable for this research topic. Categories 2 and 3 will be analysed by emphasising on 2 main factors which are the factor of lighting and ventilation.

Lighting

Lighting can be divided into daylighting and artificial lighting.

a. Daylighting

Daylighting is defined as natural light that penetrates into the building through openings either from the wall or the roof (Yacan, 2014). Sufficient daylighting that penetrates into the classroom will be able to provide a heathier place for learning as it helps to lower down user stress level (Yacan, 2014). According to a study that has been conducted by Heschong Mahone Group, students who sit in a classroom that received higher amount of daylighting perform better academically than students who sits in a classroom that received lesser amount of daylighting (Innova design group, 2019). Hence, daylighting is deemed to be the main light source for a classroom to boost up students' learning performances. For this study, the daylighting elements that will be focused on are the room orientation, sun screening, window in relation to viewing and the type of window (VELUX Group, 2019).

Daylighting will be analysed by using several elements such as room or window orientation, sun shading devices and type of window. For room or window orientation, according to Mahdavi (2015) and MS1525, the best orientation for using daylighting in a room is the north and south oriented windows while the east and west oriented windows are not suitable due to excessive daylight in the morning and afternoon respectively (Mahdavi, 2015; MS1525, 2019). For sun shading devices, a satisfactory interior environment can be achieved by providing a balanced luminance distribution, contrast but not excessive (Moreno, 2015).

For the type of window, there is no specific regulations and guideline have been specified for the usage in the kindergarten in Malaysia but there is a guideline that states the minimum area required for openigs such as window to naturally ventilate the classroom as stated in the Uniform Building By-Law (UBBL). For naturally ventilated classroom, the total area for all the windows in a classroom shall consists of minimum 20% from the room area and 10% of it shall be openable which allow natural

ventilation but it is not applicable to mechanical lighting and mechanical ventilated classroom (Uniform building by-law, 2010).

b. Artificial lighting

Artificial lighting is defined as light that is produced to light up a space by using energy (Moreno, 2015). For artificial lighhting, the choice of lamp and luminaire will be analysed. According to Akubah (2016), the minimum lux per square meter for a classroom is 300lux (Akubah, 2016).

Factor of Ventilation

Children spend more time in school besides their house (Dahari and Ya, 2011). Hence, the indoor air quality plays an essential role in kindergarten. Ventilation can be categorised into three types which are natural ventilation, artificial ventilation and hybrid ventilation. Natural ventilation is defined as an air exchange process where the natural forces of wind deliver the fresh air into the building through openings (Walker, 2010). As mentioned by Atkinson (2009), mechanical ventilation is good in maintaining a constant indoor room temperature but natural ventilation has better air exchange quality (Atkinson, 2009). Mechanical ventilation is defined as an air exchange process that involves a system that uses ductings and fans to circulate the internal air without relying on the exterior environment (Adamovsky, 2008). Hybrid ventilation on the other hand is the mix of both natural and mechanical ventilation (Adamovsky, 2008). Poor ventilation in a classroom will increase absenteeism and reduce children performance in the kindergarten (Rosbach, 2013). Therefore, ventilation will be used as one of the factors in analysing the spatial quality in a kindergarten.

As a summary, it is important to include daylighting in a kindergarten classroom due to the advantages that daylighting provides such as increasing student performance and providing healthier place for learning (Heschong, 2013). Hence, daylighting shall be the main light source for a classroom to boost up the children's performance while artificial lighting shall be the secondary light source. For the study on lighting factor, the room or window orientation, sun shading devices used, type of window, and the number of artificial lighting used in the classroom will be the main elements to be focused on. Observation will be done on user movement and response towards all the elements as stated above in both of the case studies and will be tabulated and discussed by comparing with data collected from literature review.

For ventilation factor, past studies have proven that good ventilated classroom with clean indoor air supply will lead to better student performance and maintaining student health while improving their attentiveness in the class (Axair Fans UK Ltd, 2016). As mentioned by Rosbach (2013), poor ventilation will lead to low academic performance in the classroom and it is suggested that the use of mechanical ventilators is necessary to improve the indorr air quality into the classroom (Rosbach, 2013). For the study on ventilation factor, type of ventilation and efficiency of the ventilation used in both case studies kindergartens will be the main focus by observing the response of user toward the existing ventilation systems used in the kindergarten spaces. The summary for elements to be highlighted in this study for both lighting and ventilation factors are shown in table 1.

Table 1 Summary on observation elements for lighting and ventilation factors

Factor	Elements	Data collection
Lighting	•Room or window orientation •Sun shading devices used •Type of window •Number of artificial lighting used	Data will be collected through participant observation and compared with data gained from literature review.
Ventilation	•Type of ventilation •Efficiency of existing ventilation method	

RESEARCH METHODOLOGY

The research was carried out in a qualitative approach and utilizes case studies as method of data collection. Observation was conducted in order to have a thorough comparative data that analyses and synthesizes on lighting and ventilation as factors of spatial quality within spaces of two selected case studies following the categories set out by Shaari M.F. (2018). It is to be noted that the scale and proportion factors are left out as this study considers the same company which is Q-dees and they follow the same policy and guideline on elements categorized under scale and proportion. The case studies were selected based on 3 main criteria as listed in table 2.

Table 2 Summary on case study selection

Case study selection criteria	**Requirement**	**Reason**	**Selected case study 1 Q-dees SS3** Conversion from dwelling  31, Jalan SS 3/72, Taman Universiti, 47300 Petaling Jaya, Selangor	**Selected case study 2 Q-dees Denai Alam** Conversion from shop lot  No.30-2 & 32, 2, Jln Elektron U16/E, Denai Alam, 40160 Shah Alam, Selangor.
1. Same academic program	-Running by same company and having same academic program	By having different academic program approach, the layout might be affected due to different arrangement of space to suit with their academic program approach.	Run by Q-Dees	Run by Q-Dees
2. Same scale of kindergarten	Minimum 2 storey in height for (dwelling) or minimum 2 unit of shop lot (shop lot)	To ensure both of the case studies having the same scale of space which allow researcher to make comparative study.	Semi-detached house with 2 storey height 274.5m² 414.2m² - outdoor space	2 unit of shop lot at 1st floor 377.5m² No outdoor space
3. Same capacity of user	- minimum 10 numbers of students - minimum 5 number of teachers	As per defined by Malaysia's Education Act 1996 (Act 550), a registered kindergarten shall consist at least 10 numbers of students.	85 students 8 teachers	50 students 6 teachers

Participatory observation has been carried out in both case studies by attending the full day class in the kindergarten with the children to obtain first-hand experience in the selected kindergarten classroom spaces by focusing on the factors of lighting and ventilation with the help from architectural elements as listed in figure 3 which act as the checklist throughout the observation process. The data collected from the observation method will be tabulated separately according to the physical learning environment category and factors. The focus space in both of the case studies are classrooms and children playground area. The overall research framework is illustrated in figure 4.

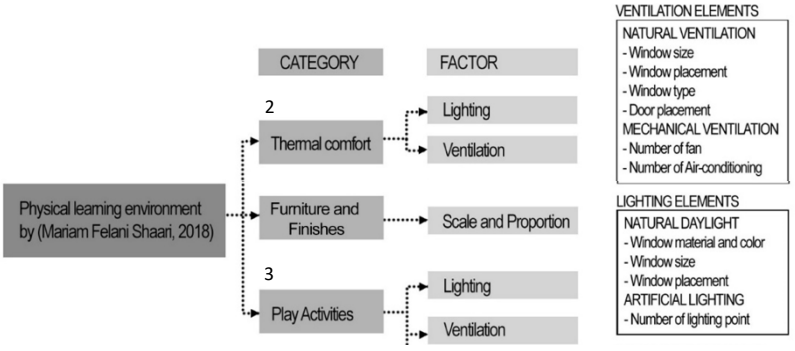


Figure 3: The categories, factors and elements for Physical learning environment

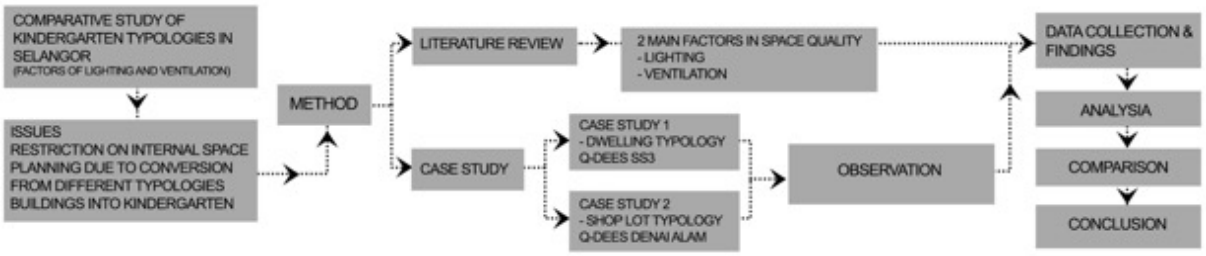


Figure 4: Research framework.

FINDINGS AND DISCUSSIONS

CASE STUDY 1 DWELLING-BASED TYPOLOGY KINDERGARTEN– Q-DEES SS3

Q-dees SS3 operates in a double storey bungalow since the year 2010 in a residential zone located at Jalan SS3 Petaling Jaya, Selangor.

- **Research focus area**
  The research focused on classroom 1, 2, and 3 (ground floor), classroom 4 and 5 (first floor) and the outdoor playground.

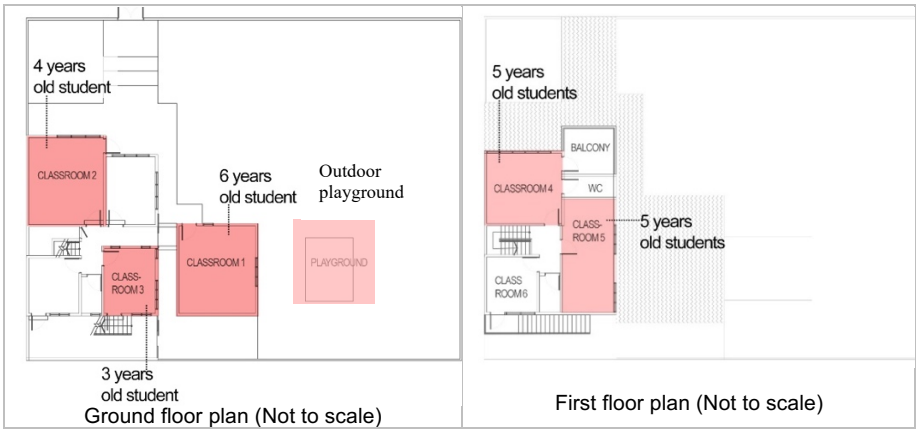


Figure 5: Classroom 1,2, and 3 location.

Category 2 - Thermal comfort

- **Factor of lighting**

Based on the observation, all the classrooms utilize a combination of both artificial lighting and daylighting as there were presence of openings (windows and glass sliding doors) as well as the availability of artificial lighting seen in use.

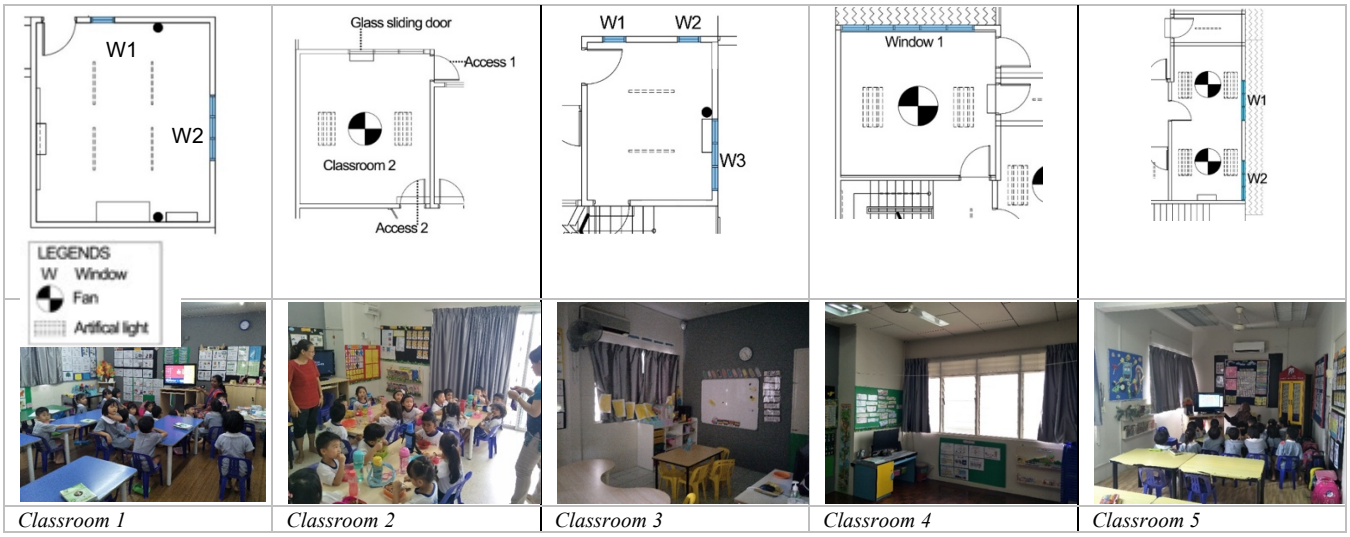


Figure 6: Location of windows or glass sliding door for Classroom 1,2,3,4 and 5.

All the classrooms were fully lit up by using artificial lighting without using daylighting except classroom 2 where it is seen partially lit by daylight. Classroom 2 was the brightest and most comfortable and classroom in the kindergarten due to the combination of both daylighting and artificial lighting. The daylighting penetrated into the classroom through the glass sliding door which is located at the south wing of the kindergarten. The location of the openings conformed with the best orientation for using daylighting in a room is through the north and south oriented windows according to Mahdavi (2015) and MS1525. Therefore, the glass sliding door in classroom 2 is deemed to be a good medium for daylighting penetration.

Figure 7: Location of glass sliding door in classroom 2.

Based on the observation, all of the windows in the classrooms had curtains. This is because classrooms 1,3, 4 and 5 had glaring issues except in classroom 2. Apart from the strategically located openings, classroom 2 also had a sun shading device installed outside of its sliding door (figure 10). For classroom 1,3 and 5, the largest windows in each classroom were facing west orientation. As mentioned by Mahdavi (2015) and MS1525, east and west oriented windows are not encouraged as it brings in excessive daylighting in the morning and afternoon respectively. Therefore, classrooms 1,3 and were seen to be more exposed to excessive daylight which caused glaring while for classroom 4, the window was designed to face south. However, classroom 4 was observed to be exposed to excessive daylight as well due to the availability of a large size window which is 4000mm(w) x 1150mm(h) that caused glaring issue as well.

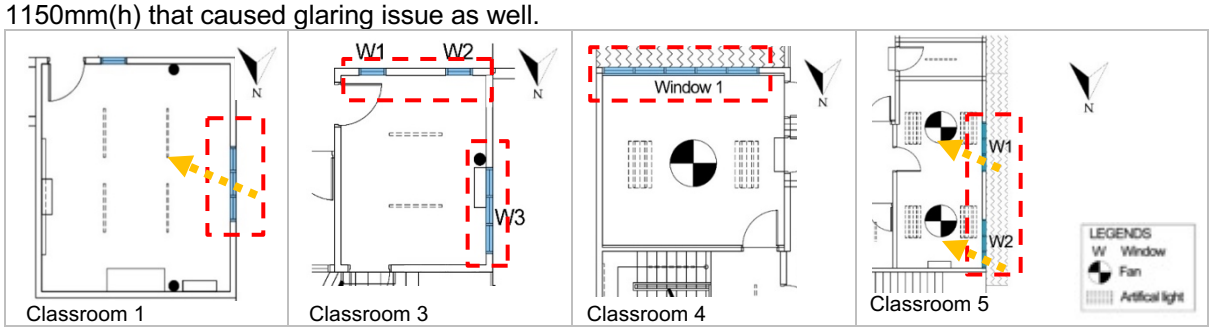


Figure 2: Location of windows for Classroom 1,3, 4 and 5.

In sum, the indoor lighting in classroom 2 is comfortable for teaching and learning due to the orientation of the glass sliding door which is south facing, as well as the availability of the permanent sun shading device and the fixed cantilever slab which helps to prevent excessive daylight from penetrating into the classroom. Hence, classroom 2 was the most comfortable classroom for learning and teaching in term of lighting factor.

Classroom 2
- Utilising both nature and artificial lighting at the same time
- Opening was at good orientation, South oriented
- fixed external control, cantilever slab and canopy to prevent excessive daylight and heat

Figure 9: Summary on the advantages of lighting factor in classroom 2.

- **Factor of ventilation**

All the classrooms in Q-dees SS3 kindergarten have glass louvre windows, however it is observed that the rooms are all equip with air-conditioning system. The teachers and students claimed that classrooms that are using air-conditioning system will feel more comfortable for teaching and learning is it optimizes the indoor comfort level compared to naturally ventilated classroom.

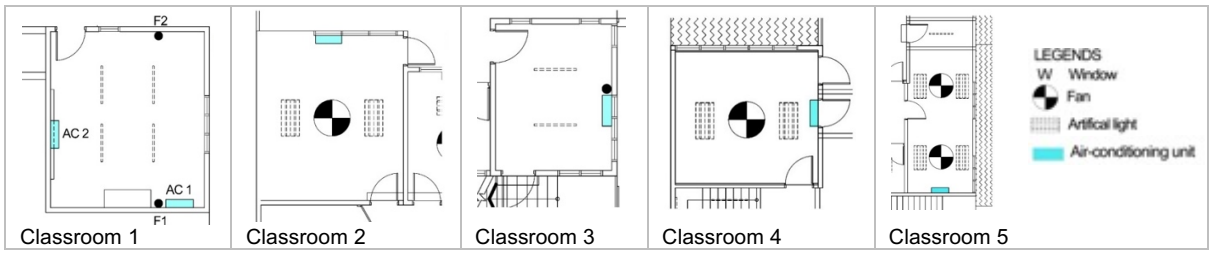


Figure 10: Location of Air conditioning unit and fan in classroom 1, 2, 3, 4 and 5.

All the classrooms had glass louvre window except in classroom 2 which had a glass sliding door. Most of the glass louvre windows are have gaps that are unable to be closed tightly as illustrated in figure 11. Hence, the efficiency of the air conditioning system became lower as the cold air could escape to the external area of the building through the gaps in between. This caused the users to set the air conditioning system to be at the lowest centigrade in classrooms 1, 3, 4, and 5 compared to classroom 2 which is using a glass sliding door instead of the glass louvre window.

Figure 3: The gap in-between glass louvre window panel.

Mechanical ventilation are good in maintaining a constant indoor room temperature but natural ventilation are better in promoting air circulation (Atkinson, 2009). Classroom 3 had the worst indoor air quality which results to bad odour in the classroom especially after snack time because the odour was not directly discharged to the external area of the building. This was also caused by the location of the room where classroom 3 is situated in between classroom 1 and 2. Classroom 3 is surrounded by a common corridor which lacks ventilation and good air circulation.

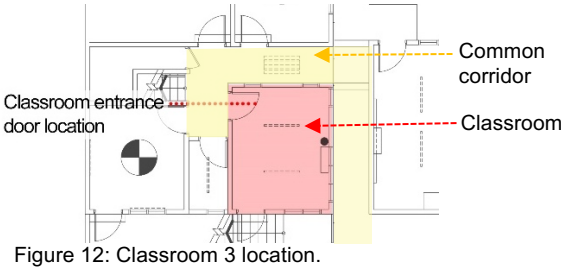


Figure 12: Classroom 3 location.

Poor ventilation in a classroom will reduce the academic performance of children (Rosbach, 2013). Hence, it is important to balance between natural and mechanical ventilation in a classroom which in Q-Dees SS3, natural ventilation is unapparent in all the classroom in this kindergarten due to high usage of air-conditioning system in all classrooms. Refer to table 3 for the summary on the factor of lighting and ventilation in dwelling typology Kindergarten.

Table 3 Summary on the factor of lighting and ventilation in Q-dees SS3

Q-Dees SS3	**Classroom 1**	**Classroom 2**	**Classroom 3**	**Classroom 4**	**Classroom 5**
Factor of lighting					
Type of lighting	Artificial lighting only	Natural and artificial lighting	Artificial lighting only		

Room/ window orientation	West oriented	South oriented	West oriented	South oriented	West oriented
Sun shading devices	No applicable	Using fixed external shading control	No applicable		
Type of window	Glass louvre window	Glass sliding door	Glass louvre window		
Factor of ventilation					
Type of ventilation	Mechanical ventilation, air conditioning				
Efficiency	Lower efficiency - used of glass louvre window. - increase chances for cold air to flow toward external.	Higher efficiency - used of glass sliding door. - reduce chances for cold air to flow toward external due to less gap in between glass panel	Lower efficiency - used of glass louvre window. - increase chances for cold air to flow toward external.		

Category 3 – Play activities

- **Factor of lighting**

The playground is located at the exterior of the building without canopy and it is totally exposed to daylighting. Children learning new things through their senses and children who play outdoors regularly are more self-directed and likely to stay with a task longer (Lund, 2018) Therefore, by having outdoor playground in the kindergarten, children will be able to enhance their social development and increase their performance in the kindergarten.

- **Factor of ventilation**

The playground is fully ventilated as it is placed in the outdoor. The main advantage of outdoor play is that the children will be exposed to the natural environment and maintaining an active lifestyle which allows children to sweat faster. Sweating is good for children system in where it helps in accelerated metabolism and improved blood circulation (Laing, 2013) Therefore, an outdoor playground is seen crucial to be made available in a kindergarten to maintain the children development and wellbeing. Refer to figure 16 for view toward the outdoor playground at Q-dees SS3.

Figure 13: Views toward outdoor playground

CASE STUDY 2 SHOP LOT-BASED TYPOLOGY KINDERGARTEN– Q-DEES DENAI ALAM

Q-dees Denai Alam operates in a three-storey shop lot since year 2017. It is part of a commercial zone located at Shah Alam, Selangor. The kindergarten occupied two units of shop lot at the first floor.

- **Research focus area**

  The research will focus on classroom 1, 2, 3, 4 and the indoor play room. Refer to figure 17 for the location.

Figure 14: Classroom 1,2,3,4 and indoor play room location.

Category 2 - Thermal comfort

- **Factor of lighting**

Based on the observation, only classroom 1 and the indoor play room had windows. This made all the other classrooms had to use artificial lighting. The artificial lights will be switched on from morning until after school period due to the absence of windows on most of the classrooms except classroom 1.

Classroom 1 has many advantages besides being able to combine both daylighting and artificial lighting, it is also the largest classroom in the kindergarten. Hence, most activities will be held in classroom 1 as it is bigger and environmentally brighter. As mentioned earlier, the best window orientation will the ones facing north and south orientation (Mahdavi, 2015; MS1525). Though equip with curtains, daylighting was able to penetrate adequately into classroom 1 through a full height window which is located at the south of the kindergarten.

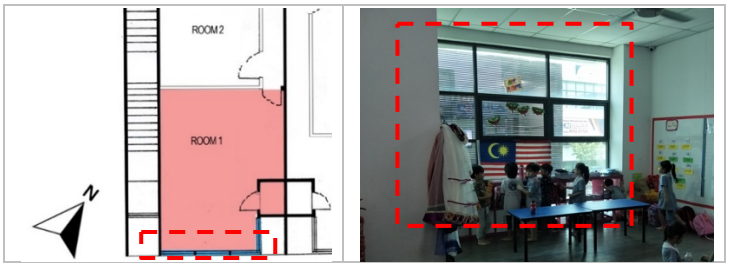


Figure 4: Location of window in classroom 1.

Although the classroom 1 is the best lit room, it is observed to have assessive shadow issue at mid-day as the the sun does not penetrate into the building through the south facing window. Therefore, the artificial lights were always switched on to ensure the students will be able to continue their reading even when the room is a little darker. This helped to maintain the lighting comfort level in classroom 1 and deemed as an effective room throughout the day for the children and the teachers. In addition to that, classroom is also equip with a blind that will be in used as an when necessary.


Figure 5: The issue on shadow casting in classroom 1

As a conclusion for lighting factor, classroom 1 was the most preferable classroom in the kindergarten due to the flexibility in providing both optimum daylighting and artificial lighting without having any glaring issues in the internal space.

- **Factor of ventilation**

The classrooms in Q-dees Denai Alam are using air-conditioning systems due to the absence of windows. Most of the classrooms were designed without windows except in classroom 1 and the indoor play room. Based on the observation, classrooms in this kindergarten uses curtain walls and openable window panels to ventilate the classroom naturally. However, due to students' and parent's preferences, all the classrooms in the kindergarten used mechanical ventilation that is the air conditioning system to achieve a more comfortable learning environment in a kindergarten.

Based on the participatory observation, the temperature in most of the classrooms were set in a medium-low centigrade to maintain at comfortable level except in classroom 1 as it is warmer in the afternoon where excessive heat penetrated into the classroom through the huge glass curtain wall. Refer to table 4 for the summary on the factor of lighting and ventilation in shop lot typology Kindergarten.

Table 4 Summary on the factor of lighting and ventilation in Q-dees Denai Alam

Q-Dees Denai Alam	**Classroom 1**	**Classroom 2**	**Classroom 3**	**Classroom 4**
Factor of lighting				
Type of lighting	Natural and artificial lighting	Artificial lighting only		
Room/ window orientation	South oriented	No applicable due to absent of window		
Sun shading devices	Using window blind	No applicable		
Type of window	Curtain walling	No applicable		
Factor of ventilation				
Type of ventilation	Mechanical ventilation			
Efficiency	Lower efficiency	Higher efficiency		

	- Heat generated from huge size curtain walling and it needs more energy to cold down the classroom	- absent of window and reduce chances for air to flow toward external through wall opening.

Category 3 – Play activities

- **Factor of lighting**

The play room is located within the indoor areas of the building it is lit up by daylighting through the full height curtain wall, as in classroom 1. Based on the observation, the play room receives a good amount daylight. According to Lund (2018), children who spend most of their time indoors with little exposure to activities show less ability to initiate or participate in new activities. Therefore, indoor play room does not bring benefit to the children except for safety and security factors where they can be supervised easily by the teachers compared to the playground.

- **Factor of ventilation**

The indoor play room depended on mechanical ventilation which is air conditioning system, hence the actual thrill of playing in a playground is degraded and does not promote benefits of outdoor play such as sweating. Sweating is good for children system in where it helps in accelerated metabolism and children sweat faster under the sun (Laing, 2013). Unfortunately, shop lot typology kindergarten was not able to provide an outdoor playground due to space restriction. Hence, children are force to play in an air conditioned environment where it reduces the sweating process which resulted to decelerating their metabolism. The major issue for indoor play room was due to space restriction where the allocated space was insufficient to accommodate the total number of students. This caused some of the students to utilize the common corridor as their play area.

Figure 17: View toward indoor play room.

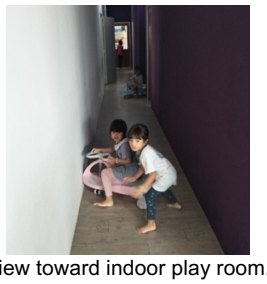


Figure 18: View toward indoor play room.

COMPARISON ON THE FINDINGS AND DISCUSSIONS FOR CASE STUDIES 1 AND 2

The preferable classroom design for each of the category from both of the case studies will be compared and discussed according to two main categories in physical learning environment with two main factors that are lighting and ventilation.

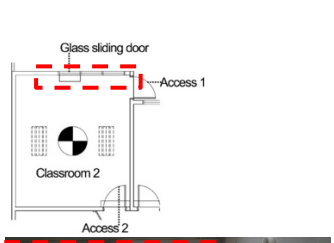
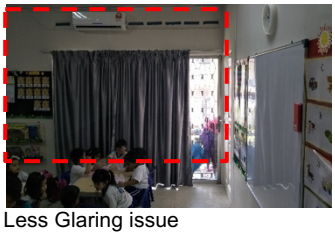
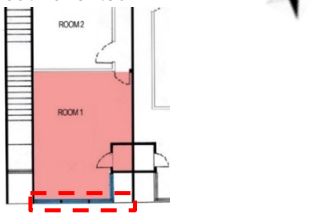
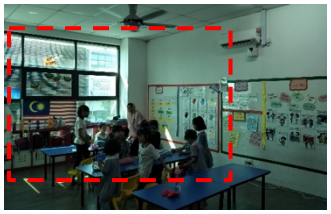
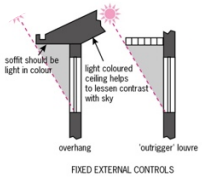
Category 1 - Thermal comfort

- **Factor of lighting**

The preferable classroom from case studies 1 and 2 for the factor of lighting are classrooms that have a combination from both daylighting and artificial lighting. As mentioned by Shishegar and Boubekri (2016), the best lighting design for a classroom shall have a good combination of both artificial lighting and daylighting. By comparing both of the classrooms, classroom 2 in dwelling typology kindergarten will have a better performance in term of lighting due to lower glaring issue. The glaring issue in classroom 2 is lower due to the presence of fixed external control, which is the sun shading device and cantilever slab on floor above which help to prevent excessive daylight into the classroom. Therefore, the lighting in classroom 2 for dwelling typology is deemed to be much more comfortable and suitable to be used for teaching and learning in a kindergarten. Similarly, Classroom 1 in shop lot typology will be referred to due to its optimum environment and balance between availability of daylighting and usage of artificial lighting to achieve comfort withing the indoor space. Refer to table 5 for the summary on the similarity and different for both preferable classroom that has been selected in term of lighting factor.

Table 5 Summary on the similarity and differences for classroom 2 (dwelling typology) and classroom 1 (shop lot typology) in term of lighting factor

Lighting factor	Classroom 2 (dwelling typology)	Classroom 1 (shop lot typology)	Literature review
Natural Lighting			
Similarity			

Type of lighting	Combination on both natural and artificial lighting	Combination on both natural and artificial lighting	The best lighting design for a classroom shall have a good combination for both artificial and natural lighting (N. Shishegar, 2016).
Window / door orientation 	Glass sliding door South oriented   Less Glaring issue - due to effective sun shading devices.	Curtain wall South oriented   Higher glaring issue - due to ineffective sun shading device.	The best orientation for using daylighting in a room is the north and south window oriented (Mahdavi, 2015)
Differences			
Type of window	Glass sliding door	Curtain walling	
Type of sun shading device	Fixed external control - cantilever slab - extended canopy More effective  	Flexible external control - brown colour window blind Less effective 	To reduce the discomfort glare from the daylight, sun shading devices can be used to reduce the daylighting penetration into the room. (Moreno, 2015).
Artificial Lighting			
Artificial lighting as main lighting source	Yes	Yes	
minimum of light needed for each classroom	Achieved	Achieved	According to research, the minimum lux per square meter for a classroom was 300lux. (Lawton, 1996)
Preferable classroom design in term of lighting factor	**Preferable classroom due to:** **- lower glaring issue** **- effective sun shading devices** **- good orientation on window**	X Not Preferable	

•Factor of ventilation

The classrooms in both typology of kindergartens are fully ventilated by using mechanical ventilation which is air conditioning system. There is flexibility for dwelling typology kindergarten classroom to utilise natural ventilation due to presence of windows in every classroom but unfortunately the flexibility

was not applicable for shop lot typology kindergarten due to the absence of window in most of the classrooms except classroom 1 which is designed with a large window with curtain walls. As mentioned earlier, air conditioned classroom will be more comfortable for teaching and learning in a kindergarten due to optimized room temperature and it is easier to maintain at comfortable temperature compared to naturally ventilated classroom where weather can be unpredictable. Due to the inconsistency of the availability of windows and the type of windows in each kindergarten typology, the factor of ventilation will have a general comparison.. Refer to table 6 on the summary for elements that affect the ventilation factor in both typology classrooms.

Table 6 Summary on ventilation factors that affect the efficiency of air conditioning in both typology kindergarten classrooms.

Ventilation factor	**dwelling typology**	**shop lot typology**	**Literature review**
a. Type of window	Glass sliding door	Full height curtain wall	Poor ventilation in a classroom will increase the absenteeism in the kindergarten and it will reduce the attention and performance of the children and end up it caused lower academic achievement in the kindergarten (Rosbach, 2013).
Efficiency on mechanical ventilation	Higher Efficiency -due to lower chance for air conditioning to seep through the gap in between window panel or jointing and flow toward external.	Lower efficiency - Higher heat gain and required more energy to cool down the classroom.	
b. Window size	Large	Large	
Efficiency on mechanical ventilation	More heat gain and required more energy to cold down the classroom.		
c. Window orientation	South oriented	South oriented	The best orientation for using daylighting in a room is the north and south window oriented to prevent excessive daylight in the morning and afternoon respectively (Mahdavi, 2015)
Efficiency on mechanical ventilation	Less heat gain and required less energy to cool down the classroom.		
d. Sun shading devices	Cantilever slab and canopy	Window blind	To reduce the discomfort glare from the daylight, sun shading devices can be used to reduce the daylighting penetration into the room. (Moreno, 2015).
Efficiency on mechanical ventilation	- Effective sun shading devices which help to reduce heat penetration.	- Ineffective sun shading devices which caused higher heat penetration.	
Preferable classroom design in term of ventilation factor	**Preferable classroom due to: -** **- effective sun shading devices.** **- good window orientation, reduce heat penetration.** **- minimise the chances for air conditioning to seep through window gap and flow toward external.**	X Not Preferable	

Category 3 – Play activities

- **Factor of lighting**

Play areas were evidently included in both typologies, however, only the dwelling typology kindergarten is placed in the outdoor. Both of the playgrounds were lit up by using daylighting where outdoor playground in dwelling typology had direct daylight from the sun while the indoor playground in shop lot typology had the daylight penetrating into the space through a full height curtain wall and large windows. Based on observation, both of the typologies had their play areas sufficiently lit.

- **Factor of ventilation**

The outdoor playground for the dwelling typology kindergarten had the advantage of having natural airable while the indoor play room for the shop lot typology depended greatly on mechanical ventilation. As mentioned by Laing (2013), sweating is good for children system in where it helps in accelerating metabolism and is able to boost the immune system and children sweat faster under the sun. Unfortunately, shop lot typology kindergarten was not able to provide outdoor playground due to space restriction. Hence, children had to play in an air conditioned environment where it reduces the sweating process. The major issue for indoor play room in the shop lot typology was due to space restriction in where the allocated space was not able to accommodate the total number of students utilizing the play room and it caused some of the students to play in the common corridor as their play area. Hence, outdoor playground will be more preferable to be equip in a kindergarten.

CONCLUSION

Based on the study, dwelling typology kindergarten is evidently a more suitable typology to be converted into a kindergarten compared to the shop lot typology kindergarten in terms of lighting and ventilation

factors. Dwelling typology kindergarten achieved better performance as listed in physical learning environment which is the thermal comfort with the factors of lighting and ventilation due to the flexibility to combine both daylighting and artificial lighting in all the classrooms. Shop lot typology kindergarten on the other hand was not able to provide this combination due to the restriction of wall openings especially intermediate shop lot unit where the openings are only available on the front and rear elevation of the shop lot. For the play areas, the dwelling typology kindergarten is able to provide an outdoor playground which bring more advantages to the children in term of lighting and ventilation. Therefore, play area is more effective for the dwelling typology, hence providing better physical learning environment for the children.

As a summary, dwelling typology kindergarten will be able to achieve better performance in most criteria as mentioned above. Hence, kindergarten operators should consider these factors in order to provide better learning environment for the students in kindergarten by analysing and synthesizing on lighting and ventilation within spaces by focusing on the classrooms and the play areas. The study has provided a comprehensive insights on the learning environment of the two laid out kindergarten typologies which act as a tool to identify the best typology when setting up a kindergarten.

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