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A Study on Integrating Water Element in Preschool to Enhance Learning Environment for Children

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The education system and the physical learning environment for children has a mutual relationship to boost children's development but the design of a kindergarten in Malaysia are restricted. The objective of this research study is to identify the possibility of water integrated design and the water-cooling strategy which is suitable to be designed in the kindergarten. A proper-planned space should have the integration of fun element which could trigger the children senses. Water is one of the elements which can stimulate the senses of human as it has a lot of potentials to be integrated into every part of the building. The availability of water helps to enhance environmental sustainability by cooling the indoor air temperature instead of having air-conditioned space. In this research study, a few precedent studies are selected to review and compare the way of integration of water in a child-friendly environment. Throughout the study, the water element has a lot of potentials to be integrated into kindergarten and could enhance certain sustainability

Keywords: Water Play, Child Learning Environment, Preschool Design, Passive Water-Cooling

1. INTRODUCTION

In our world today, the water element is always being integrated as part of the architecture to enhance the aesthetic value of the overall building as water prompt to influence human spirit at rest or in motion. The amalgamation of the water element and building could manipulate the beauty of architecture while the movement of water could upgrade the spatial experience of the building occupants. Yet, water is a simple element which able to stimulate human senses and mental connection to affect human's behaviour. The presence of water could be in any form as water could sews or separate the spaces and gives its serenity by reflecting the environment(Yurtyapan Salimi, Salimi, & Kara Pilehvarian, 2016).

The preschool education is critical for three to five years old children where it is an indispensable period of children growth in terms of growth, cognitive development, non-cognitive development which these will affect the children's life later (Bjorklund & Pellegrini, 2000). Children's development and behaviour is affected by the built environment of the classrooms in preschool while the design and technology incorporated to the preschool facilities could benefit the process of learning and teaching (Martin, 2004). Thus, it is important to reinforce the integration of water element into their physical learning environment to enhance child development physically and psychologically.

By engaging the water-sensitive urban design approach, the local water bodies are protected, stormwater management could be upgraded and having achievement in water conservation to promote a sustainable future (Lam, 2017). People always applying some passive water-cooling techniques to cool the environment and achieve thermal comfort in ancient time. This is because

water is a sustainable resource which is an effective cooling source. In the study, the appropriate passive water-cooling technique for the preschool environment is determined to enhance the learning environment and to promote natural ventilation within the spaces for children and teachers.

2. PROBLEM STATEMENT

Learning through play including water play could benefit children's development but the design of the kindergarten in Malaysia unlikely integrate water element as part of the architecture in the preschool environment (Mohidin, Ismail, & Ramli, 2015). The major constraint of the preschool design is the location and the chosen building typology to run the preschool which most of the kindergarten is located by the corner of terrace housing or shophouses. Young children should have more opportunity to be exposed to the natural environment and spend time in the wetland to train their large motor skill and fine motor skill but it is a rare occurrence in the 21st century especially children living in the city area (Bailie, 2012). The implementation of water design could stimulate the senses of children and improve their critical thinking and creativity where water could be integrated into many ways.

The rising of the industry had created plentiful pollution and wastage of water consumption. It is necessary to promote green building by implementing water efficiency design approach and the proper management of water resource (Sheth, 2017). Water is a type of renewable sources which able to cool down a building interior efficiently and has high potential to replace mechanical ventilation as reducing the emission of greenhouse gases. Sustainable green feature such as a rainwater harvesting system could be designed to reduce the usage of potable water from the main tap.

3. RESEARCH QUESTIONS & STUDY PURPOSED

Water element able to nurture child development physically and mentally in a positive way. First, the study is to improve the children learning environment through water element enhancement as a different kind of existence of water could stimulate different senses of children. Then, this study is to have a better understanding of the role of water in architecture and investigate the potential of passive design regarding water in a tropical climate. The passive cooling design with the incorporation of water element in the physical learning environment could promote a more sustainable future and teaching the next generation about the importance of conserving the freshwater resource. By conducting this study, a better understanding and reference can be achieved to form a foundation for future research.

The research objectives are formulated as follows:

- To identify the possibilities of design with the integration of water and the role of water element to enhance the physical learning environment for young children.
- To investigate the passive cooling design by incorporating the water element to promote sustainability in the preschool learning environment.

4. METHODOLOGY

Several research questions are produced with collectively research objectives regarding the research study. There are a few methods applied to conduct the thesis paper to determine the design possibilities of integrating water element in the preschool learning environment and identify the appropriate passive water-cooling technology for a preschool building in a tropical climate. First, the literature review is done before the research regarding the theories of incorporating water element in the architecture, the impact of different integration of water element to children's behaviour, the passive water-cooling techniques in the current market.

Then, qualitative content analysis is carried out to analyse the selected precedent study from a foreign country which integrated water element in the preschool environment and the practicality to have the water play design to support the research findings. Some architecture which involves the design of water management and water feature also being studied to understand the technical system especially for those which supporting sustainable design. Moreover, further discussion based on the data obtained from the survey questionnaire to collect their opinions towards the integration of water in the young children physical learning environment to support the findings.

5. FINDINGS

Precedent studies based on journal articles and websites are compared and generated into a table. The basic criteria for selecting the precedent studies is the existence of water feature design in the preschool environment. The result obtained from the survey questionnaire is further analysed to understand the public's preference towards the integration of water feature in preschool.

Precedent Studies

Fuji Kindergarten as illustrated in Figure 1 is in Tachikawa, a suburb of the city and the construction is completed in the year 2007. The kindergarten could accommodate 600 children aged two to six years old. The educational approach is to maximize children's freedom to discover their learning environment which is treated as a giant playground. The water faucets in Figure 1 were designed at the ground floor courtyard for children to wash away the dirt on them or their boots easily and train them to be more discipline ("Educational Facilities," 2011). The height of water faucets is capped at 55cm and intentionally designed to meet the needs of the disabled child which is one of the important considerations. The roof is composed of decking design and water run-off gradient at 1/50 to 1/70 to harvest the rainwater (Tezuka, 2017).

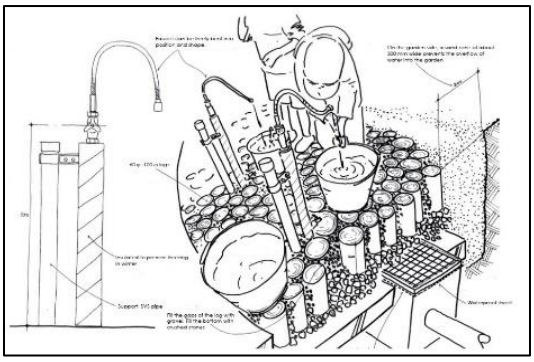

Figure 1: Aerial View of Tezuka Kindergarten (top) & Water Faucets (bottom) (Source: Tezuka, 2017)

Muku Nursery is located at Fuji City of Japan and completed in the year 2018. It occupies the total area of 537m^2. The arrangement of circular spaces is completely free from geometrical restriction and increase the transparency of visibility. Teachers could watch the children from the office easily and ensure the safety of children even there is a water playground in the centre of the kindergarten as illustrated in Figure 2. The dish has a gentle slope and the depth is only 30cm which is safe for children to play around (Tezuka Architect, 2020).

Figure 2: Muku Nursery (top) and Water Disk (rightbottom) Photograph by Kida Katsuhisa

D1 Kindergarten and Nursery as shown in Figure 3 is designed by Hibinosekkei Architect. The project scale is 1161 m^2 and located in Kumamoto, Japan. In the middle of the building, an atrium is designed as a semi-outdoor space as illustrated in Figure 3. The ground floor of the atrium act as a basin to collect water during rainy days, meanwhile, the water will freeze and become ice skating rink in winter. For such big opening atrium, the external screen is installed on the outer periphery to block the strong sunlight and control the amount of rainfall into the building. The shallow water at the basin and big opening of the atrium could promote good natural ventilation while the wind cross and the water can

reduce the indoor temperature. The depth of the water basin is around 3cm to 5cm which the water level can reach the ankle height of the young children and they could enjoy playing with such shallow water without any drowning risk.

Figure 3: D1 Kindergarten and Nursery Exterior (top) and Central Atrium (bottom)
Photograph: Studio Bauhaus, Ryuji Inoue

The differences of design with the integration of water are tabulated in Table 1 for a clearer understanding.

Table 1: Comparison Between Selected Kindergarten

Precedent Study / **Design Criteria**	**Fuji Kindergarten**	**Muku Nursery**	**D1 Kindergarten and Nursery**
Type of water feature integrated	Water faucets and large basin	Water disk	Slightly sunken atrium
Location of water feature	Internal Courtyard	External Courtyard	Atrium of the building
Water Play Area Surface Finishes	Stone and Soil	Concrete	Concrete
Adjacent Floor Finishes	Soil and concrete	Concrete and stone pavement	Concrete
Water Temperature	Depends on weather	Depends on weather	Depends on weather
Finishes Colour	Brown	Grey	Grey
Water Depth	None	Ankle-depth	Ankle-depth
Interaction between children and the water feature	High (Flexible water faucets)	Medium (water disk will not be operated during winter season)	High (natural ice skating rink during winter season)
Level of supervision	360 degrees of visual and physical supervision	Transparent design for visual towards the water disk	A central atrium is in open planning
Sustainable feature	Rainwater harvesting	None	Evaporative Water Cooling

Survey Questionnaire

The questionnaires were distributed to the public to collect the data for further analysis. There is a total number of 138 respondents participated which are general public consist of parents, single adult and elderly to determine their opinion towards the integration of water feature and design in the physical environment of the kindergarten.

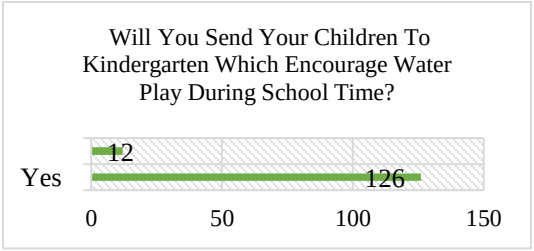

Figure 4: Respondents' Preference Towards Preschool Which Provides Water Play Facilities

As the bar chart shown in Figure 4, 126 respondents chose to send their children to kindergarten which encourage water play as one of their teaching methods. Meanwhile, there is a minor group of respondents with a total number of 12 people who decided not to send their children to such kind of kindergarten. This result shows that the community could accept the water play as part of the learning session. The topmost choice of desirable water feature is having water play channel outside the classroom according to

the selection in Figure 5. Secondly, interactive water fountain scores the second highest votes which are 89 votes from the questionnaire. From the result obtained, we can understand that the public prefers the water features which children can interact with.

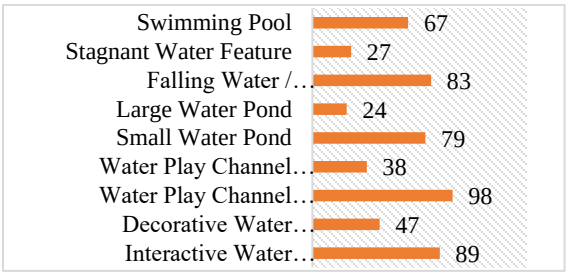

Figure 5: Preferable Water Feature Design in Kindergarten

Moreover, the public has a different opinion towards the integration of passive water cooling according to the bar chart in Figure 6. Evaporative water-cooling wall with the combination of large shallow pond attracted the most interest of the general public and got 92 votes which are higher than evaporative water-cooling wall only which got 79 votes. Their thought is the effect of combination might give a greater effect on passive cooling for the indoor air quality.

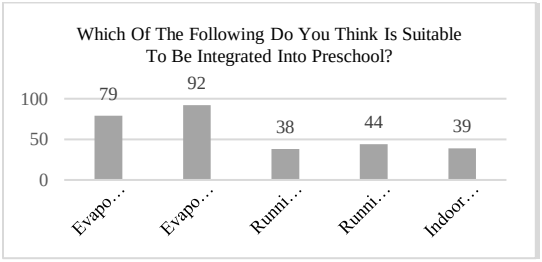

Figure 6: Respondents' Preference for Passive Water-Cooling Feature

6. DISCUSSION

The water play features are integrated into preschool where a few considerations are taken in. A decorative water feature such as water curtain wall could enhance the overall aesthetical value and able to generate white noise. Shallow water basin and interactive water fountain require larger space to install. Meanwhile, the decorative water fountain is more flexible and could be designed based on the size and pattern to fit in the preschool. Water channel within the classroom or outside of the classroom is acceptable but it requires high maintenance to ensure the water quality as children will contact it frequently. The wading pool is applicable for a smaller-scale kindergarten as the capacity is smaller and easier for supervision. The easiest installation of the water feature is a water table where the maintenance required is minimal. The surface finishes of the water play feature should apply the aggregate base and reinforced concrete as the base to support the boulder sink and water channel above while the finishes for the water channel is the combination of sand and gravel embedded finishes which help to increase the slip-resistance. The pond liners are added to capture any water that seeped through the cracks on the floor. Besides, the pavement for the walkway adjacent to the channel could be rough texture surfaces such as flagstone or pavers which should not be slippery. For the flat land surface with interactive fountain or water play equipment like aquatic playgrounds, rubber and urethane components which have water resistance and chemical resistance is used as surface finishes. By having a high contrast colour of the rubber mat as recommended in Table 4 between the location of equipment and orientation path could assist the children for better wayfinding.

Table 2: Recommendation for Colour Combination of Surface

Yellow + Purple	**Green + Purple**	**Orange + Blue**	**Red + Green/ Blue**

Finishing material could be considered based on budget, children's safety, durability, maintenance and the matching style with the overall building design. For the surface adjacent to the water play zone, slip resistance is the main concern where children will run around with their wet feet. Next, the heat reflectivity of floor finishes is also important as the weather in Malaysia is hot. Concrete is recommended due to the cheap installation cost and it could reflect solar radiation to provide comfort for bare feet. The labour cost to install flagstone and pavers are slightly higher but they could enhance the aesthetic value. Furthermore, the maintenance for poured concrete finishes is easier which is regular cleaning and resealing the crack lines. The joints between pavers need to be refilled with sand regularly to prevent the growth of small plants.

7. CONCLUSION

As Malaysia is propelling towards a fully developed nation, the quality of education facilities should be improved especially the preschool education facilities because it is the first school that every child is attending. Having an interesting and fun preschool could allow children to discover their potential and talent. Based on the research, a few design strategies to integrate water feature in the kindergarten can be concluded as shown in Figure 7 for future development. First, a water feature which could generate white noise such as a water turbine and water curtain wall can be located near to the classroom or spaces usually occupied by the children. The white noise will allow the children to concentrate in class and reduce their anxiety. Then, the wading pool and shallow water channel can be designed for indoor or outdoor based on different climate. Furthermore, interactive water play design shall be in child-friendly and safe for children to play. For instance, the huge water table which requires a small water storage tank and a pump to maintain the water motion to push the floating item for children to scoop up. By having this feature, children could train their motor skill and arm muscle by scooping up the item which is requested by the teacher.

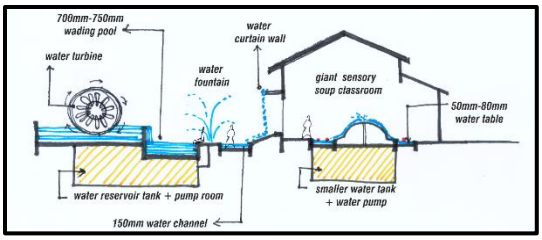

Figure 7: Strategies to Coordinate Water Feature Design

Moreover, sustainable design strategies such as a rainwater harvesting system, passive water evaporative cooling wall, water cooling ceiling and water-cooling floor as concluded in Figure 8. A kindergarten with green building features allows children to have awareness for reducing the consumption of electricity and maximize water efficiency. This is to educate children about the importance of sustainability. The gutter to catch rainwater could be transparent to harvest sunlight and allow children to watch the water motion during rainy days and the passive evaporative cooling wall can be integrated to cool the interior space by natural ventilation and replace the mechanical ventilation.

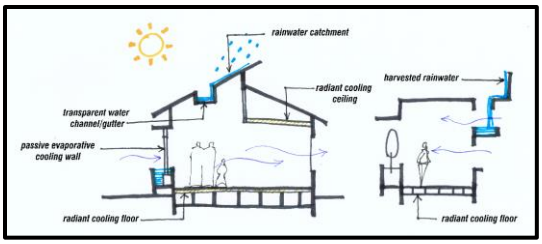

Figure 8: Strategies to Integrate Sustainable Design Related to Water Element

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