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Ergonomic Building Design Consideration of an Earlylearning Centre

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Abstract - *Children training through game playing are more effective than traditional academic methods. Therefore effective training can be one of the ways for improving the children's capabilities and development. The purpose of the project is to plan and design an 'Early learning centre' according to the standard parameters, which will end to more secure and safe doors, windows, playground, emergency consideration etc. are studied. This project is intended to provide a model in designing environment for kids. Various parameters such as floor area for indoor as well as outdoor activities, their shapes and position, natural and artificial lighting, door-ways and a child care following Indian standard which is functional in their design, cost effective to operate and environmentally safe and secure. Anthropometric measurements of children are also considered while planning the childcare as they are essential to ensure the safety and security and are crucial to the child's development and experience.*

Key Words: **Early learning centre, Anthropometry, Parameters**

1. INTRODUCTION

Early education plays in improving a child's future academic performance, health and quality of life. The quality of this environment has a profound influence, especially given that many children spend close to half working hours in a childcare center. The 'Early learning center 'is a place where children experience the world and through which care givers and the community gave support.

Learning is an active process whereby the opportunity to explore and interact with the development. key components in a child's growth and sequence A child's growth follows a developmental environment are that is universal, but that within that sequence, each child proceeds at different rate and in unique ways.

Early childhood education or early learning centre is a branch of education theory which relates to the teaching of young children (formally and informally) up until the age of about eight. Infant/toddler education, a subset of early childhood education, denotes the education of children from age two to age four and half years.

Hence there is a need to provide stimulating and developmentally appropriate challenges for the individual child in a warm, secure, environment. The aim of the center is to provide consistent, high quality care to meet the needs of the active, continually developing child.

2. METHODOLOGY

When designing a space or product we must know the body dimensions of the prospective user. Reason for applying ergonomic design are that accidents, reduced productivity, ineffectiveness and user discomfort may arise from incorrect product dimension that do not match those of the user.

Anthropometric is a term used to describe the measurements of a user population for which the space is designed. Measurements are reported in terms of the range of body measurements of the particular population.

It is a well-known fact that there are serious ergonomic problem among the preschool children and toddlers of India. In fact proper design guideline for an early learning center does not exist in our country. The absence of reliable ergonomic and anthropometric data of school aged children, which measurements take in to account the application for which the children living and working spaces, furniture and equipment are designed as well as the dimensions of the children, can serve as the national in attentiveness to design principles of an ELC.

In light of these problems and in the absence of data, the following methodology was under taken to meet the urgent need for the design guideline of an ELC.

Firstly, it is need to be known who you are designing for. The group you are designing for is called user population. We consider 2.5, 3, 3.5,4 and 4.5 year old children as the user population. The anthropometric data of children of these age group were collected from Ahalia public school. The measurements of 14 anthropometric characteristics of children which constitute a set of basic data for the design of functional spaces and furniture were used. The children were made to be in sitting and standing positions to take both static as well as dynamic measurements. Next the optimum values of the furniture were calculated based on the anthropometric data previously acquired. In calculating the optimum dimensions, dynamic or static anthropometric measures, minimum and maximum values, and also the function of the furniture were taken in to considerations. All of the furniture was divided in to two groups according to reach and volumetric function based on the main criteria of anthropometric design. The different formulas for calculating the optimum values of different furniture is obtained as follows,

Maximum values were calculated for volume measurements.

Furniture dimension = X + (SD x Z)

Minimum values were calculated for reach measurements,

Furniture dimension= X - (SD x Z)

where, X is the mean and SD is the standard deviation of the anthropometric measurements of different age group children. Z is a constant value corresponding to 95 percentile confidence interval.

The next step of our project was to provide suggestions for the various parameters we identified through literature review. The parameters are

- Green building
- Space arrangements
- Openings
  - ✓ Doors
  - ✓ Windows
- Hard ware locations in doors
- Materials
  - ✓ doors and window materials
  - ✓ flooring materials
  - ✓ roofing materials
- finishes
  - ✓ ceiling finishes
  - ✓ wall finishes
  - ✓ floor finishes
  - ✓ skirting of tiles
- color
- fire protection, environmental and safety issues
- Child safety.

2.1DESIGN OF FURNITURES FOR ELC

The dimensions of the living and working space of buildings, the types of material and different riggings should be designed to conform to the user's anthropometric measures. Anthropometric measures are the most frequently used ergonomic data during the design process. In our project, anthropometric data is used in the design of children's equipment and furniture used in an Early Learning center. The anthropometric data of 2.5, 3, 3.5, 4, and 4.5 years old children were used for design.

The design features that play significant roles in the design of a final product are: aesthetics, economics, functionality and originality. The functionality of furniture is based on its comfort, safety and usefulness. And these qualities of comfort, safety, and usefulness are related to the anthropometric characteristics of the user and the suitability of materials used in furniture design.

2.2 METHOD USED

In order to calculate optimum furniture dimensions anthropometric measures were taken from a total of 55 children under age group of 2.5 years to 4.5 years were used. A total of 14 different measurements were made while the children were the in sitting and standing positions. In calculating the optimum dimensions of the furniture, dynamic or static anthropometric measures, minimum and maximum values, and also the function of the furniture were taken into consideration. All of the furniture was divided in to two groups according to reach and volumetric function based on the main criteria of anthropometric design.

The formula for calculating the optimum furniture dimension is a form of normal distribution in probability theory. The general equation for maximum and minimum is calculated.

Maximum values were calculated by: Furniture dimension = X + (SD x Z)

Minimum values were calculated by: Furniture dimension = X – (SD x Z)

Where X = Mean or Expectation of distribution

SD = Standard Deviation

Z = Constant corresponding to assumed confidence interval

Here we are taking the normal distribution with a confidence interval of 95% ,i.e., the chances of any error occurring in our design is limited to 5% and is verified too. Thus the value of Z is taken as 1.96.

Calculations of the depth, height and breadth of the furniture and equipment which are considered to be used rather frequently by children were done. Anthropometric data of children were used when calculating the measurements.

3. DESIGNS

3.1TABLE DESIGN

- Table depth (for one person) (max, value) = Forward elbow reach (X) + (SD x Z)

Table depth (for one person) (min, value) = Forward elbow reach (X) - (SD x Z)

- Table breadth/ width (max. value) = Buttock-knee depth (X) + (SD x Z)
- Table height (max. value) =0.41 x (total height (X) + (SD x Z))

NOTE: The minimum values are obtained by connecting the standard deviation by minus sign (-) instead of plus sign (+).

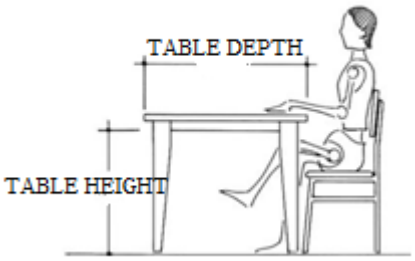

Fig 1: Table Depth and Table Height

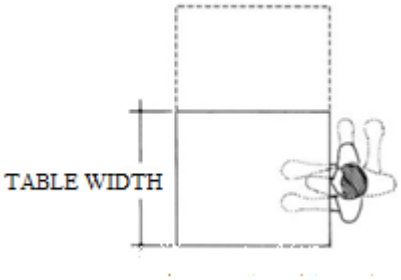

Fig 2: Table Width

Sample calculation (All dimensions are in cms)

Table height max value (age group 2.5 years) = 0.41 x (108.009 + (1.96 x 4.7)) = 48.060 cm

3.2 CHAIR DESIGN

- Chair depth (max. value) = 0.6666 x (Buttock-knee depth (X) + (SD x Z))
- Chair breadth/width (max. value) = Hip breadth (X) + (SD x Z)
- Chair height (max. value) = Sitting height (X) + SD x Z
- Seat rest height (max value) =0.75 x (upper part while sitting(X) + (SD x Z))
- Hand rest height (max value) =0.25 x (upper part while sitting(X) + (SD x Z))

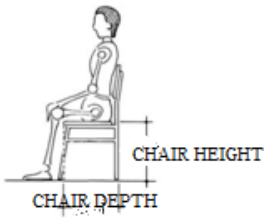

Fig 3: Chair Height and Chair Depth

Fig 4: Chair Width

Sample calculation

Chair height (max value) (age group 2.5 years) = (26.4+ (1.96 x 1.0274)) =28.413 cm

3.3 DESIGN OF BEDS AND BUNKS

- Bed breadth (max. value) = 2.5 x ((Buttock knee depth (X) + (SD x Z)) – (Hip width (X) + (SD x Z)))
- Bed length (max. value) = Stature (X) + (SD x Z) + (pillow)
- Bed height (min. value) = Sitting height (X) + (SD x Z)
- Bunk height (max. value) = (height of lower part while sitting (X) + (SD x Z)) + (height of upper part while sitting + (SD x Z))

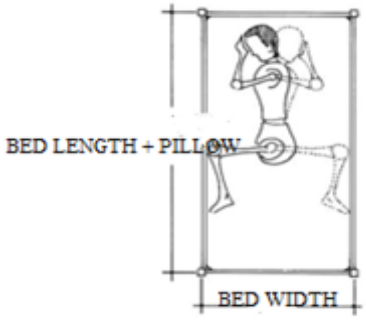

Fig 5: Bed Length and Bed Width

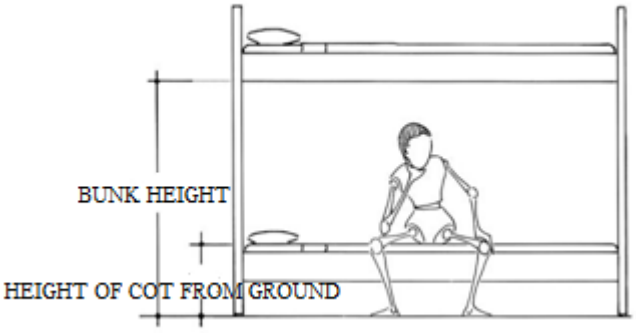

Fig 6: Height of Cot from Ground and Bunk Height

Sample calculation

Bed length (max value) for age group 2.5 years =108 + (1.96 x 4.7) = 117.2 cm

3.4 DESIGN OF TOILET ACCESSORIES

- Water Closet pan height (max. value) = Sitting height (X) + (SD x Z)
- Wash basin height (max value from ground) = height of leg while standing(X) + (SD x Z)
- Distance of person to tap(max value) = (Forward reach of arm(X) + (SD x Z))

Fig 7: Height of Water Closet

Fig 8: Wash Basin Details

Sample calculation

Water Closet pan height (max value) = 27.8727 + (1.96 x 1.89) = 31.577 cm

3.5 DESIGN OF CLASS ROOM UTILITIES

- Cupboard height/shelf height (max. value) = Eye height (X)+ (SD x Z))
- Switch height (max value from ground) = (0.75 x total height(X) + √2 forward reach of arm) + (1.96 x (1.75 x SD $_{\text{total height}}$ + √2 SD $_{\text{forward reach of arm}}$))
- Black board height (max value)= 0.44 x (Total Height (X) + (SD x Z))

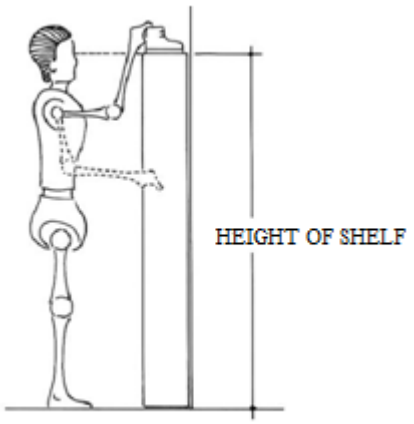

Fig 9: Height of Shelf

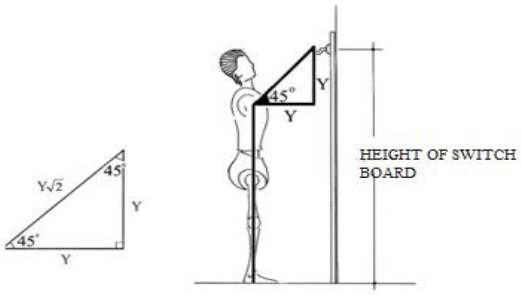

Fig 10: Height of Switch Boards

Sample calculation

Shelf Height (max value) = 93.1919 + (1.96 x 1.67) = 96.4641 cm

The measured anthropometric details along with their mean values standard deviation, error, margin of error, intervals are presented below along with all the maximum and minimum values of the design for age group.

4. RESULTS

The various furniture dimensions were calculated using the formulae mentioned earlier and a comparison between the existing range of furniture dimensions and the obtained value was made as shown in the table below.

Table 1: Comparison between Existing and Calculated Values

Parameter	Existing Value (Cm)	Calculated Value (Cm)
Table depth	20-40	23-36
Table width	25-35	28-39
Table height	40-48	34-48
Chair depth	15-20	19-26
Chair width	33-37	19-37

Chair height	24-28	24-32
Seat rest height	37-50	18-54
Hand rest height	5-20	6-18
Bed width	50-80	52-62
Bed length	80-120	83-112
Bunk height	-	49-104
Cot height from ground	20-30	24-73
Cupboard height	124-145	74-96
Switch height	75-90	95-153
Blackboard height	110-130	100-128
Water closet pan height	24-28	24-31
Wash basin height	45-52	56-62
Distance of tap from person	20-30	26-46

The minimum value of calculated furniture dimension corresponds to the age group of 2.5 and the maximum value corresponds to the age group of 4.5.

Here we see that there are variations in the existing values of furniture dimensions and the calculated values. These variations are mainly due to the fact that here, the furniture dimensions are calculated according to Indian Standards by considering the anthropometrics of the Indian children. So for the safety and comfort of the students in the Early Learning Centre, the furniture dimensions should be designed according to the calculated values.

5. CONCLUSIONS

The design guideline for an ELC has been prepared. By referring this guideline, a safe, efficient and child friendly ELC can be designed which is fully functional in design, cost effective to operate and environmentally safe and secure .

The design guidelines have been prepared based on the identified parameters from the literature studies of ELC of other countries.

The prepared guidelines are purely based on Indian Standards so that Indian children can use these living spaces, working spaces, furniture and other equipment in safe as well as comfortable manner. And hence, the center will provide consistent, high quality care to meet the needs of the active, continually developing child.

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