



# Designing for Children

## - With focus on 'Play + Learn'

### **Design for difference**

Cognitive Enhancement Toys for Children with Developmental delays

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**Abstract:** Childhood is a phase where children explore, learn and enjoy. For some children, this phase is full of difficulties. These children suffer from either developmental delays or learning difficulties. According to sources, in India, there is prevalence of 1.5-2.5% of developmental delay in children under 2 years of age. Development is described into five different domains - gross motor, fine motor, speech and language, cognitive and socio-emotional. These children need help in early age to overcome developmental delays and for cognitive enhancement. Both parents and teachers are involved with children right from early age and they can devise ways to help these children. Many schools adopt 'Play' as an important activity to help these children overcome developmental delays and "toys" are mostly central to the design of such activities.

The paper describes the design research carried out for designing toys for cognitive enhancement of children with developmental delays between the age of 2-5 years. In the first phase of research, interview method was used to understand what kind of learning difficulties children are facing and what kind of methods are employed to teach them; also to understand what types of toys they are using. The sample size of 20 comprising of teachers, therapists and pediatricians from Special schools and departments for special need children in mainstream schools was used for the interview purpose. Observational studies with children (5 different classrooms with children between 3-5 years age) were carried out to understand how children learn and use the toys. At the end of first phase, the qualitative analysis led to the shift from the problem area of learning difficulties to developmental delays. In the second phase, survey of available products in market was conducted to understand what types of toys are used to address what type of developmental activity for these children. Mapping of the play methods employed by the teachers and therapists to the type of activities the toys were targeted for, led to finding the Design gap. The design process incorporated the research findings. The product is designed in the form of a Toy Box that has multi-utility set of toys for cognitive enhancement in children with developmental delays. The design (three set of toys) addresses the communication, spatial, cognitive, gross motor & fine motor skills of children with developmental delays. The designed product was put through user

testing twice to incorporate the findings from the testing to make the design more user friendly for the children as well as the teachers, therapists, and parents.

**Key words:** *children with developmental delays, toy design, cognitive enhancement*

## **1. Introduction**

Childhood is a phase where children explore, learn and enjoy. For some children, this phase is full of difficulties. These children suffer from either developmental delays or learning difficulties. With United States alone having prevalence of 10% (Westeyn T.L. et al, 2012), India is estimated to have more than 10% of its children population having developmental delays and learning difficulties in coming years (RBSK, 2013).

Developmental delays could be symptoms of learning difficulties that are neurologically based processing problems. At initial levels, they affect the academic learning abilities of children. As the children grow, they can also interfere with higher level skills such as organization, time management, reasoning, and abstract thinking. Learning difficulties can affect these children's life beyond academics and can impact their relationships with family, friends and colleagues. Learning difficulty is found across all ages and socio-economic classes. In countries like ours, it is still a taboo to talk about developmental delays or learning difficulties. Parents take long time to acknowledge that their child could have learning difficulty. Ignorance about it is prevalent and it does a lot of harm to these children's development due to delayed intervention. These children need help in early age to overcome developmental delays and for cognitive enhancement. Both parents and teachers are involved with children right from early age and they can devise ways to help these children. Many schools adopt 'Play' as an important activity to help these children overcome developmental delays and "toys" are mostly central to the design of such activities. The aim of this research is to find gap for designing toys that serve as instructional tools for cognitive enhancement for children with developmental delays. This design research is qualitative in nature and employs the interview and observation methods.

## **2. Background**

Learning difficulties is an umbrella term used to describe wide variety of learning problems in developing children. The term "Learning Difficulties" was first recommended in the Warnock Education Report in UK in 1978 which describes these children with learning difficulties as special need children. These children may have one or few of these conditions: Dyslexia (difficulty with reading), dyscalculia (difficulty with Math), dysgraphia (difficulty in writing) and dyspraxia (difficulty with motor skills). According to study

conducted by Jayanti Narayan and team, the deficits in these children may vary from visual perception, auditory perception, visual motor activities, to conceptualization, memory, and attention. The children with learning difficulties face problems with learning pace in the schools. Their problems aggravate in schools since more often than not, these learning difficulties are quite invisible.

### **3. Remedial measures**

In the last two decades, there has been a lot of research happening in the field of learning difficulties to identify and assess the learning difficulty and its level. A common understood method of identifying any learning difficulty is if the child is two levels below his normal level of attainment of the activity (it could be reading, writing, math, or involving motor skills), the child is regarded as having learning difficulty. The studies indicate that at least there should be a consistent discrepancy of 2 class levels or more in one or more academic subject areas to call the child as having learning difficulty (Narayan J. et al, 2003). It is only in recent years that there has been acceptance for these children's special needs and schools are taking efforts to cater to such children in mainstream schools. Also many special need children schools have been set up where these children are provided remedial teaching. S. Ramaa and her team did extensive research with Indian children in schools to identify specific difficulty, assess the level of learning difficulty and symptoms, and developed remedial measures that involved individual settings and small group activities to be applied in Indian conditions (S. Ramaa, 2000). Other studies also show that the children with learning difficulties often show disinterest in study oriented classroom setting. And since these children have conditions like impulsiveness, poor comprehension, inability to follow instructions etc., an interventionistic approach becomes more fruitful (Okimoto A.M., Bundy A., Hanzlik J., 2000).

#### **3.1 Role of 'Play' as intervention method**

The early detection of the learning difficulties leads to a better intervention and instructional design for young children. It is observed that traditional assessment tools for children with learning difficulties often give a limited picture of their abilities and contribute very little to the development of meaningful instructional designs. In recent times, play has come to be recognized as an effective way of assessment of learning difficulties since through play, children demonstrate most of their abilities naturally and toys are often central to such play settings. "Play provides opportunities for acquiring many cognitive skills. Although play is often thought of in terms of 'Free Play', dictated by

the child, play can also be educationally focused, directed by the teacher or parent to reach specific educational goals” (Singer D. et al, 2006). Many recent researches explore the use of ‘augmented play toys’ as against the normal observation methods for identification at early ages in case of more number of play functions (Westeyn T.L. et al, 2011). In their comprehensive research on ‘play’ as an assessment tool, Eisert & Lamorey discuss the growing interest of researchers in using play as a tool for assessment and in their findings, suggest further investigation into ‘play’ as a tool for intervention and instructional design (Eisert & Lamorey, 2010). This research gap is significant and can lead to findings that are useful for more play-toy based instructional designs.

#### **4. Primary Research**

##### **4.1 Interviews & Observation studies**

The research intended to find the data that is required for designing toys that can enhance cognitive development for children with learning difficulties. The primary research addressed the following research questions: (a) what kind of learning difficulties children are facing? (b) what kind of methods are employed to teach them? (c) what types of toys they are using?

Since specific information about children was needed which is qualitative in nature, interview method was chosen for question (a). A sample size of 20 comprising of therapists, pediatricians and teachers from Special schools and departments for special need children in mainstream schools was used for the interview purpose. The questions included what specific activities that are hampered in the children, what kind of difficulties are found in these children, what kind of stimuli are needed. The findings of qualitative analysis of the interviews are shown in the combined table (Table 1).

A very important finding from interviews is of identification of learning difficulty that it cannot be diagnosed definitively before the age of 7 in these children, although the developmental delays can be identified and they may be symptoms of learning difficulties.

For questions (b) and (c), ‘observation’ method was chosen. Observation is a valuable method since it provides insights about play behaviors and mental representation in play and language contexts seen in these children (Vig Susan, 2007). For observational studies children between 3-5 years of age were chosen from 5 different classrooms from 3 schools to understand how children learn and use the toys. Observation studies for one session (40 -50 mins) were conducted. The average size of class was 15 children. Observation also included the instructors/teachers.

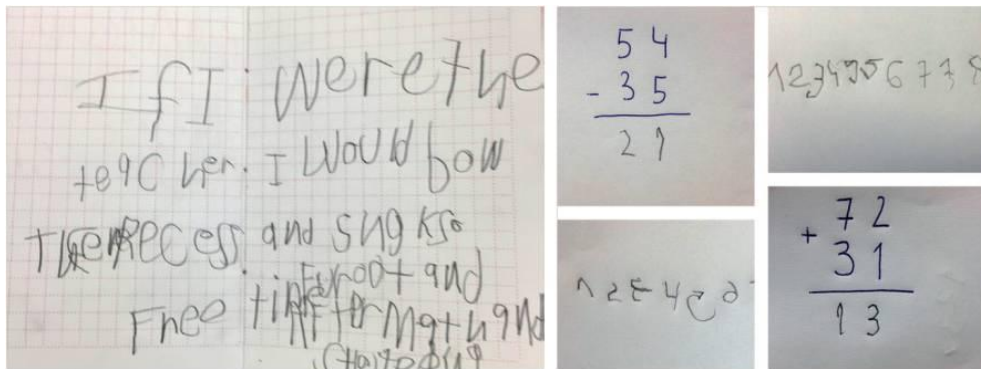


Figure.1 Writing and math samples of children from observation studies

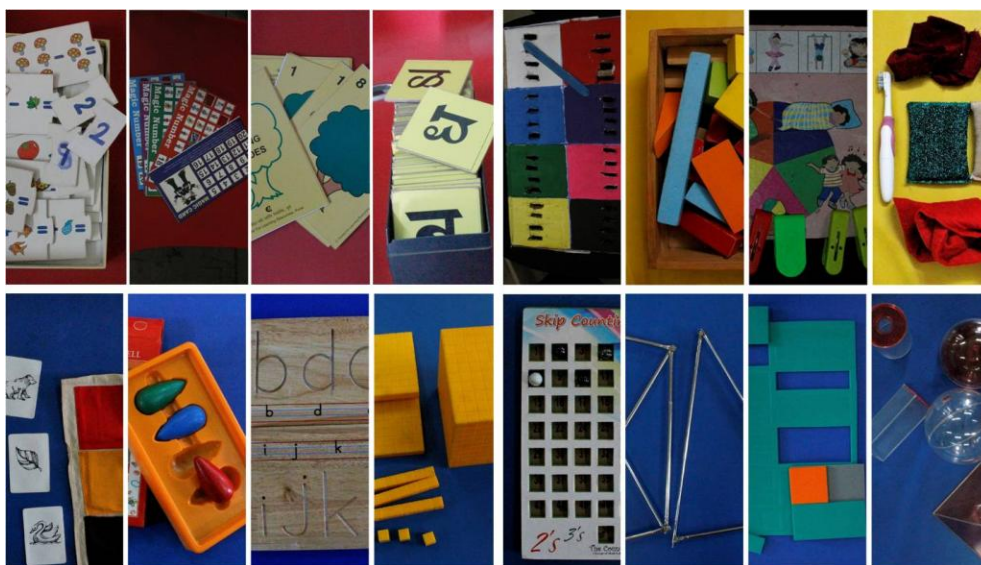


Figure.2 Toy samples from observation studies

The overlapping contents from both interviews and observations were grouped together and inferences were drawn (Table 1). At this point, the problem area of learning difficulties is shifted to developmental delays inferring to the finding from the interviews. Some important findings from the study:

- In almost all classrooms, no text books were used.
- Teachers designed their own learning material, game and activity.
- The grouping of children in class is done according to the target learning area and based on their learning needs.
- Each child has their own curriculum.
- Four learning styles were targeted: visual, auditory, kinesthetic and tactile.
- Too many toys throw children into inactive zone because of lack of stimulation.

Themes	Specific activities hampered	Target Areas	Teaching methods employed	Toys used	Inference 1 (Interviews)	Inference 2 (Observation studies)
GROSS MOTOR	Grip, holding, lifting, & moving	Gross Motor Skills	<ul style="list-style-type: none"> <li>Passing the Ball</li> <li>Catch &amp; throw</li> <li>Lego Blocks play</li> </ul>	<ul style="list-style-type: none"> <li>Big size Ball</li> <li>Lego Blocks</li> <li>Wooden blocks</li> </ul>	<ul style="list-style-type: none"> <li>Toys that involve pressing.</li> <li>Lifting &amp; moving objects</li> </ul>	<ul style="list-style-type: none"> <li>More exploratory activities are needed for Gross and fine motor skills.</li> </ul>
FINE MOTOR	Grip, holding, picking, writing	Fine Motor Skills	<ul style="list-style-type: none"> <li>Sensory objects</li> <li>Tong activities</li> <li>Bead play</li> <li>Wearing buttons</li> <li>Tying thread</li> <li>Packing their own bag</li> </ul>	<ul style="list-style-type: none"> <li>Soft materials like sponge, rubber etc.</li> <li>Hard materials like sand paper, wooden blocks, stones, brush etc.</li> <li>Beads &amp; Threads</li> </ul>	<ul style="list-style-type: none"> <li>Let children touch different objects and textures.</li> <li>Sorting exercises.</li> <li>Hand-Eye coordination exercises.</li> </ul>	<ul style="list-style-type: none"> <li>Sensory objects are quite helpful for muscle training.</li> <li>Tong Activities and Bead play was found to be successful with children.</li> </ul>
COGNITIVE	Reading, math, & comprehension	<ul style="list-style-type: none"> <li>Learning Abstract concepts (taught through concrete concepts)</li> <li>Creativity/thinking</li> <li>Counting</li> <li>Addition &amp; Subtraction</li> <li>Letter &amp; word recognition</li> </ul>	<ul style="list-style-type: none"> <li>Story telling</li> <li>Teaching through Cards</li> <li>Beads &amp; Buttons play</li> <li>Lego Blocks play</li> </ul>	<ul style="list-style-type: none"> <li>Books</li> <li>Graphic cards</li> <li>Story board</li> <li>Flash Cards</li> <li>Alphabet cards</li> <li>Magic cards</li> <li>Puzzles</li> <li>Beads &amp; Buttons</li> <li>Lego Blocks play</li> </ul>	<ul style="list-style-type: none"> <li>Use the strong point of the child. For ex: the child is not good at reading and writing, but is good at remembering. Then convert all the concepts to stories.</li> <li>Go from concrete objects to abstract concepts.</li> </ul>	<ul style="list-style-type: none"> <li>Children directed to some activity through story telling can be more beneficial in learning.</li> <li>Cards can be an active tool for learning</li> <li>Cards can be used in conjunction with other play activities.</li> </ul>
SPATIAL	Gazing distances, gaps, heights, objects	<ul style="list-style-type: none"> <li>Color &amp; shape recognition</li> <li>Form Recognition</li> <li>Space comprehension</li> </ul>	<ul style="list-style-type: none"> <li>Passing the Ball</li> <li>Catch &amp; throw</li> <li>Lego Blocks play</li> </ul>	<ul style="list-style-type: none"> <li>Big &amp; small size Ball</li> <li>wooden blocks</li> <li>Lego blocks</li> </ul>	<ul style="list-style-type: none"> <li>More toy requirements for preprimary level children.</li> <li>Building &amp; sequencing play.</li> </ul>	<ul style="list-style-type: none"> <li>Ball play is helpful in spatial understanding.</li> <li>Packing their own bag was a good method to learn organization but it lacked to motivate children enough to do it neatly.</li> </ul>
COMMUNICATION	Communication & expression	<ul style="list-style-type: none"> <li>Social skills</li> <li>Communication</li> </ul>	<ul style="list-style-type: none"> <li>Story telling</li> <li>Teaching through Cards</li> </ul>	<ul style="list-style-type: none"> <li>Books</li> <li>Graphic cards</li> <li>Story board</li> <li>Flash Cards</li> <li>Alphabet cards</li> <li>Magic cards</li> <li>Puzzles</li> </ul>	<ul style="list-style-type: none"> <li>Visual stimuli required.</li> <li>Verbal prompts required.</li> </ul>	<ul style="list-style-type: none"> <li>Story telling is rather a passive activity for children but can be made interactive.</li> <li>Cards can be used in conjunction with other play activities.</li> </ul>

Table 1. Theme grouping of findings from interview and observation studies

At this point, since problem area shifted to developmental delays, for analysis, findings from both the interview and observation studies were grouped under 5 themes: cognitive, spatial, communication, gross motor & fine motor skills, based on the 5 domains of development in children: (1) Cognitive Development (2) Social and Emotional Development (3) Speech and Language Development (4) Gross Motor Skill Development (5) Fine Motor Skill Development. (<http://www.howkidsdevelop.com/developSkills.html>)

## 4.2 Market Research

After the interviews and observation studies, market survey of available Toys for developmental delays was done. The sources included Specialty toy stores, general toy stores and online stores.

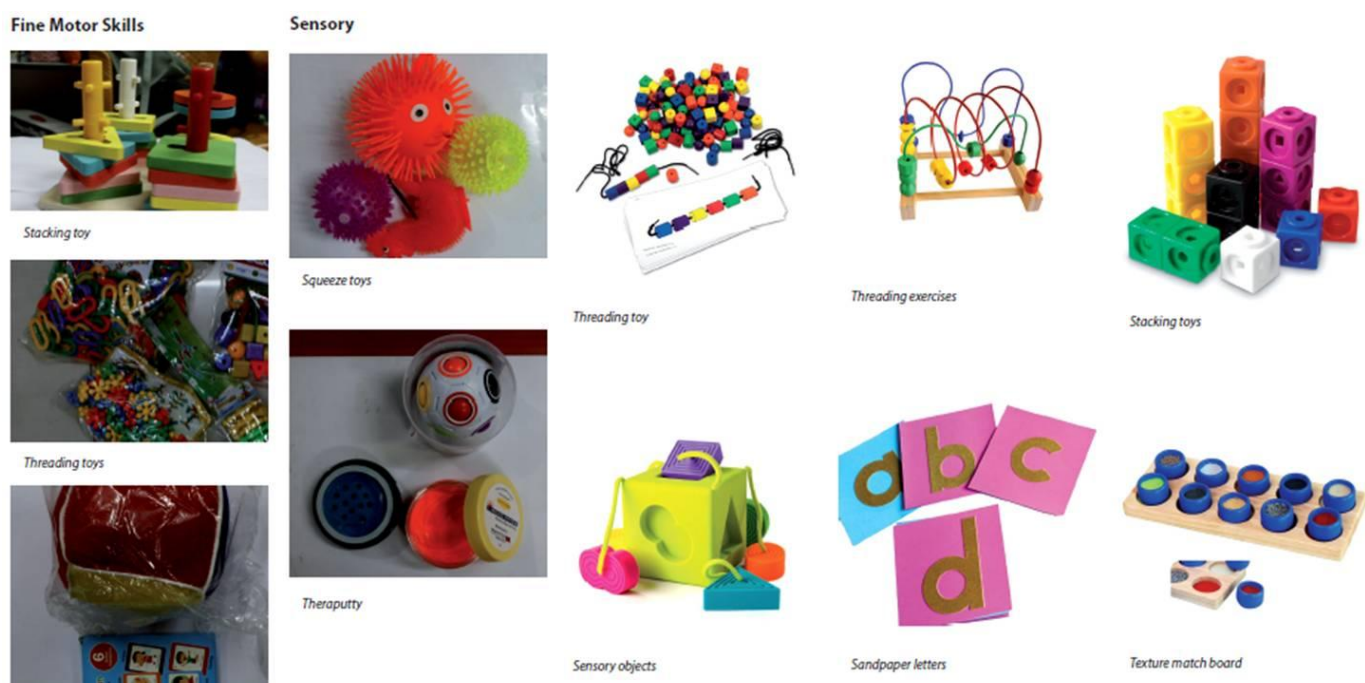


Figure.3 Grouping of Market Toys

The toys from the market were grouped according to the themes and were mapped with the target areas. Findings (Design gap) of the market research:

- Most of the toys are made of plastic which is hazardous for children.
- Limited sensory toys and sorting activity toys.
- Limited forms of blocks.
- Limited toys for word recognition. Only flash cards available.
- Toys do not cover multiple target areas.

## 5. Design Concept

### 5.1 Explorations

Design exploration was done with the 5 themes in mind: Spatial, Gross motor, Fine motor, Cognitive, and Communication. Based on the inferences and findings from market studies, the toys were ideated and clubbed as per the target themes (Fig. 5). Initially different forms of stacking blocks, fitting blocks, soft sensory blocks with press buttons, match board with fitting pegs, various stamps with textures and flip board for word recognition and math activity were designed. The material for the toy set was chosen as pine wood as it is sustainable, lightweight and non hazardous for children.

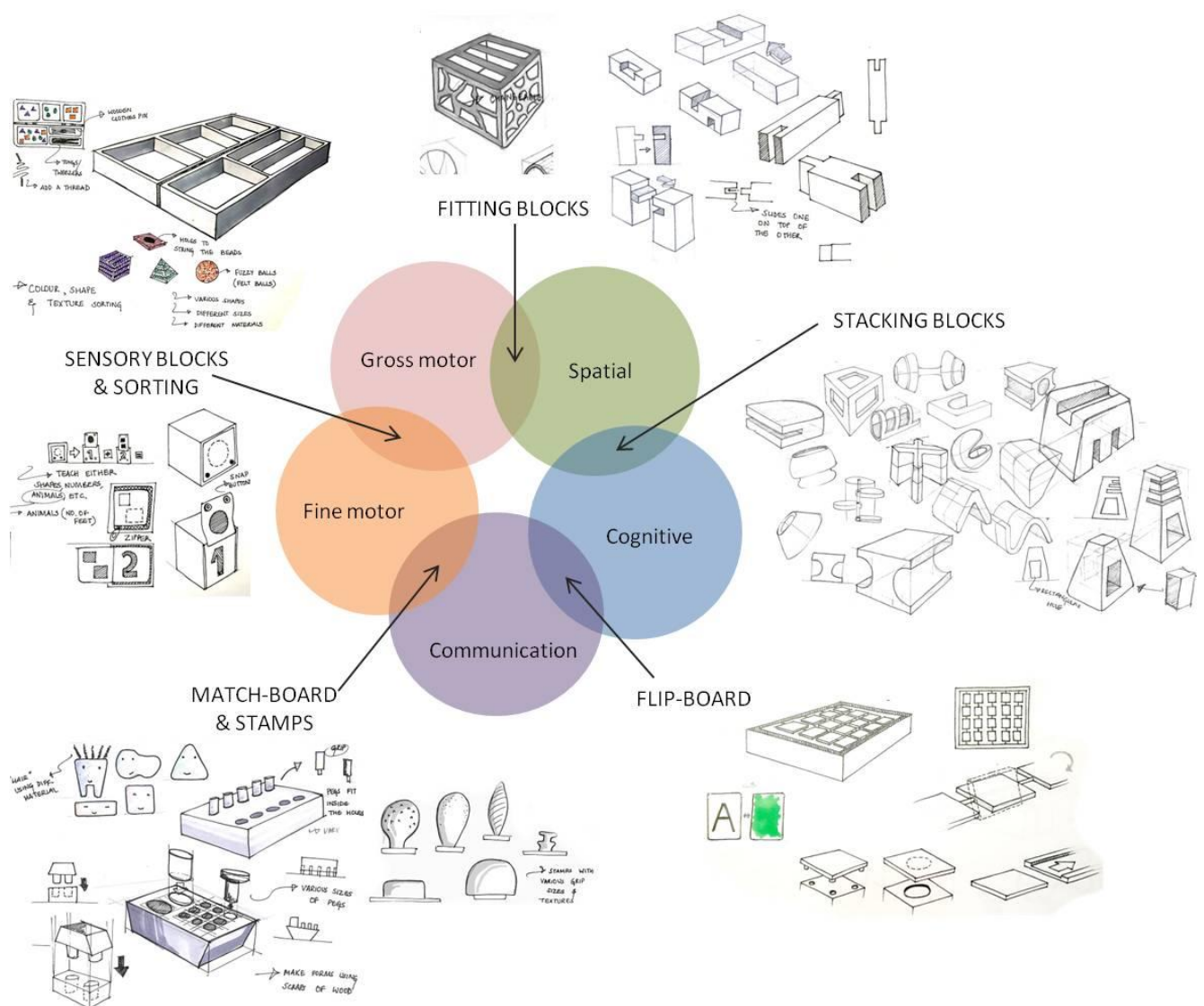


Figure.4 Design explorations for Toy





Figure.5 Mock-ups of initial design

## 6. User Testing

The first set of Toy mock-ups (Fig. 6) were then user tested. The mock-up toys were given to the same set of children who were part of observation studies. Each toy set was given to the children and observations recorded spanning 20 minutes. The findings of the observations and the further design implications decided is shown in Table 2.

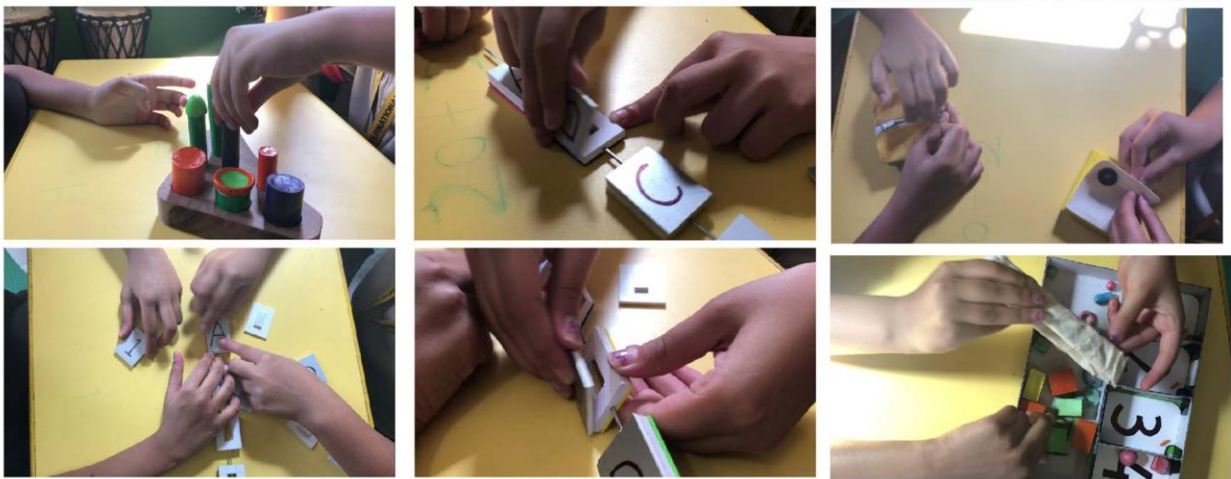


Figure.6 First User Testing

Themes	Toys Tested	Observations	Design Implications
GROSS MOTOR	FITTING BLOCKS	The porous box and fitting blocks activity was very predictable for children and did not lead to any further learning.	Discard Fitting blocks toy since it is a level lower for the target group. (children of 2-5 age)
SPATIAL		Other set of fitting blocks were too difficult for the children to figure out since they all looked the same and children could not clearly distinguish between the tongue and its groove.	Discard these Blocks since they were way advanced for the target group.
COGNITIVE	STACKING BLOCKS	Children found stacking Blocks were interesting and easy to use and they could explore many activities and build different forms.	Go ahead with Stacking Blocks choosing the favorable forms.
SPATIAL		Children were trying to weigh and press/squish the blocks in their hands.	Use of both wood and silicone for the blocks so that children can learn the concept of weight and balance.
COMMUNICATION	FLIP BOARD	Some children needed prompting from teachers to recognize and form the words. Teachers could create word and math puzzles using the squares by flipping.	Design Flash Cards to use with the puzzles.
COGNITIVE		Children were able to use the detachable alphabet and number squares easily and they were able to form words.	Go ahead with the Flip Board toy.
FINE MOTOR	MATCH BOARD & TEXTURE STAMPS	Though children took interest in playing with this, the pegs were heavy for them to fit into the slots in the matchboard and they dropped them many times.	Discard Match Board.
COMMUNICATION		The size of the stamp was too small for the children to feel the texture on it and soon they got messy with the ink. They also needed stimuli for the activity to be meaningful.	Discard texture Stamps.
GROSS MOTOR	SENSORY BLOCKS & SORTING TOYS	The buttons and zippers on the Sensory blocks were hard to open as the blocks were too small to hold.	Discard Sensory Blocks but add them without buttons and zips to Stacking Blocks set.
FINE MOTOR		The beads in the Sorting toy were too small to lift with tweezer. Further, the act of picking beads became difficult since the sorting boxes were joined and gave too little space for movement of hands. Needed verbal/graphic stimuli.	Add different sized hard and soft beads to the Sorting toy. Design separate sorting boxes. Create a Sensory Puzzle on top of these separate boxes that will prompt children to pack the toys after use.

Table 2. Findings and inferences of the first User Testing

## 7. Design Development

Based on the first user testing observations (Table 2), further design implications were decided (Fig. 7). Now, there is more overlap of the target domains for each toy. The Fitting blocks, Sensory blocks, Match board and Texture Stamps are discarded. Sensory blocks made of silicone (as Silicone is easily moldable and non harmful material for children) are added to the Stacking blocks. Also sponge blocks with different surface textures are added to Stacking block set. A handbook that includes flash cards and set of communicative stimuli for the parents/teachers is designed for use with Flip Board, stacking blocks, and sorting toy. Big and small sized beads of different colors are added to Sorting toy. Separate boxes are designed for sorting activity. A sensory puzzle is designed on the lids of these boxes that prompt children to pack the toy set.

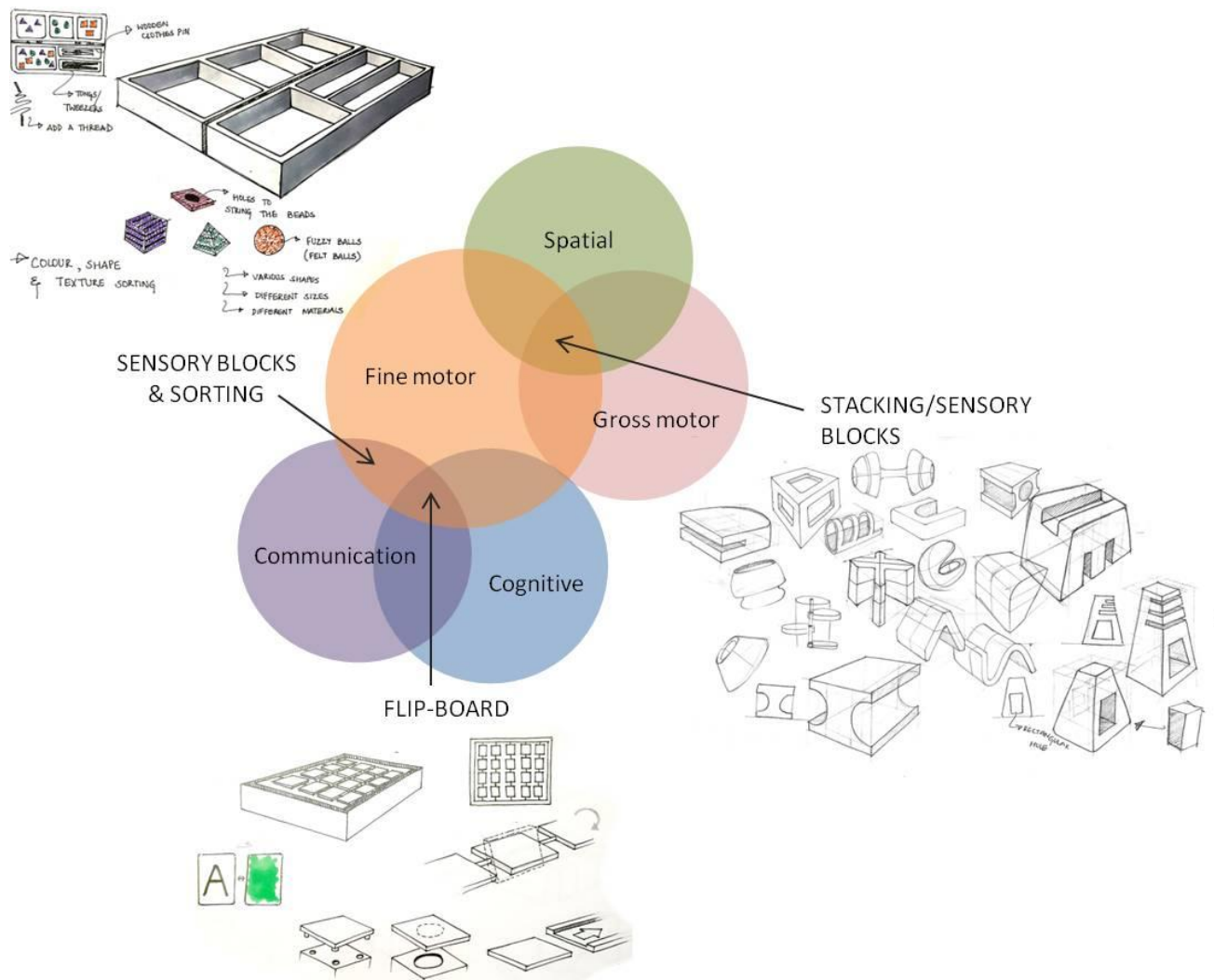


Figure.7 Design development after first user testing

## 8. Second User Testing

The set of Toy mock-ups developed after first user testing were given to the same set of children who were part of observation studies. Each toy set was given to the children and observations recorded spanning 20 minutes. Interviews were carried in dyad session during user testing for validation of the effectiveness of the toy set as well as the handbook.



Figure.8 User testing and product validation

## 6. Result and Conclusions

The toy set was found to be used by the children with minimal difficulties. Children were able to stack the blocks and play around with the different weights and textures of blocks. Children were able to use tweezers and clips in the Sorting toy and sort the beads according to size and color on the instructions. The separate boxes were helpful in better sorting. The instructors were able to use the squares on Flip board effectively for alphabet and word recognition, world building, counting and simple math, providing stimuli with help of the handbook. The detachable pieces on flip board found to be easy for children to remove and replace.

The research was conducted to find the design gap of Toys for children with developmental delays. The toy set addressed the domains of cognition, gross and fine motor, spatial and communication in these children. Though the design could address some aspects of developmental domains with toys, there is huge scope for research into how children learn using toys and how toys can be designed as instructional tools.

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