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Review of educational toy design elements and their importance in child development from a cognitive perspective

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Abstract
Children perceive by using their senses to gather and understand information and respond to the world around them by cognitive effort. Perception, attention, memory, and thinking are all interconnected mental processes in human cognition. The ability to perceive surroundings through the light that enters the eyes is called visual perception. Visual perception in children is an essential ability of their brain to connect and make sense of what their eyes see. The visual perception of colours, patterns, and structures has been an essential factor concerning a product because these are perceived exclusively through vision. Good visual processing skills benefit reading, writing, math, and other essential aspects of learning. As children in their preschool days learn from educational toys, the designs of the educational toys should consider enhancing their learning. Additionally, educational toys have become one of the tools used to teach children in many aspects, bit by bit. Research shows that learning through play is an integral part of a child's development. Cognitive skills developed in the early stage of life and use of educational toys can enhance these. Educational toys help children develop fundamental abilities such as cognitive thinking and problem-solving. Since toys are essential for the development of children, the National Education Policy of India has given the focus on toys and the enhancement of local toys. Moreover, learning while playing has been made a part of the curriculum. However, for manufacturing such effective educational toys, the manufacturer has to consider various factors like safety, colour and shape and other design factors that enhance their development. Therefore, in this review article an attempted was made to identify a gap in literature and discuss the importance of design in educational toys for development of children.

Keywords: Educational toy, design, cognition

1. Introduction
According to Neisser (1967) [1], the term' cognition' refers to all actions and processes involving the acquisition, storage, retrieval, and processing of information, regardless of whether these processes are explicit or conscious. Human cognition, perception, attention, memory, and thinking are interconnected mental processes. Children see the world around them by utilising their senses to absorb and analyse information and exert cognitive effort to respond to it. Learners can use cognitive strategies to pursue goals they are already motivated about (Malone and Lepper, 1987) [2]. Educational toys can be called cognitive tools since they can drive children to achieve specific goals. The instructional or cognitive tools are designed to boost motivation and engagement while improving retention and higher-order thinking abilities (Hogle, 1996) [3]. Educational toys have also become crucial instruments for children's development since they help to stimulate and extend playtime (Goldstein, 2012) [4]. Toys that are well-chosen can encourage children to play with others, collaborate, or acquire specific abilities. Furthermore, children's mental and physical development is influenced by their interaction with instructional toys. However, if educational toys' design parameters and safety are considered, an educational toy can help children develop. *Toys* can be defined as tangible goods used to play. Educational toys are animated objects designed for children to stimulate cognitive, physical, and psychological development (Jaffe, 2006) [5]. Educative toys are an effective way of child development as toys are very entertaining and cater to the curiosity of modern children (Zhang and Jiang, 2009) [6]. Educational toys can be used as a tools to develop particular skills in cognitive development, motor development, social development and emotional development. These three components serve a significant role in the growth and development of children, which should always be considered for their relationship with intellectual achievement and the emotional well-being of the children (Elkind, 2008) [7].

Elements include shape, colour, space, form, line, value, and texture, all of which are essential characteristics of any visual design. The way a piece of work is perceived, executed, and used is influenced by design aspects (Dewey, 1980). A product's design elements have an impact on children's learning. Colour has been demonstrated to alter memory performance through the increasing intentional level and arousal and affect cognitive task performance (Elliot & Maier, 2014) [8]. According to research by Mehta and Zhu (2009) [9], changing hues can alter "performances on different sorts of cognitive activities." Moreover, if all of the design aspects that influence children's learning are considered while creating educational toys, the educational toys will be highly effective.

1.1 Purpose
As play is an essential part of child development, educational toys have become tools used to teach children in many aspects. According to the report by Economic Service Group, National Productivity Council New Delhi, 2017, in India, the toy industry is dominated by tiny and cottage businesses. There has been a rich tradition of local toys in India. Since toys are essential for the development of children, the National Education Policy of India has given the focus on toys too. Learning while playing, making toys, etc., has been a part of the curriculum. However, for manufacturing such effective educational toys, the manufacturer has to consider various factors like safety, colour and shape and other design factors that enhance child development.

According to the importance of educational toys and their design and safety related to children, in this review, the researcher compiled the related articles and assessed them to identify a gap in the literature and discuss the importance of design in educational toys for the development of children. Further, focusing on the significance of design elements in educational toys, some important researchable areas for developing educational toys are identified to enhance children's cognitive learning process.

2. Methodology
To gather scholarly articles for this review, a literature on educational toys and their design in child development was searched. The database was searched for references between years 2012 and 2021. The following search terms were used: Children and educational toys, educational toys and its design, child development and educational toys, children and design of educational toys, children and design elements, design elements and cognitive development of children and design elements and learning in children. Firstly, 40 relevant last 10 years papers were identified and finally after reading the abstract 8 articles were included in our study. The inclusion criteria were as follows: Studies written in English in peer-reviewed journals from 2012 to 2021 were included. The search criteria focus on the research intentions to discuss the importance of design in educational toys for development of children. The papers which contributed to only toys development were excluded and only those contributed to educational toy designs for child development and learning were included.

3. Results and Discussion
The main results of the selected papers were discussed in following sections:

3.1 Educational toy design and children
Page and Thorsteinsson, 2017 intends to add to the theory of effective toy design by emphasising the importance of toys in children's development. This study aims to assess how children play and investigate the toys they typically use to determine how they impact their maturity. A questionnaire was given to 28 participants ages 18-25 years old in addition to the interview; the subject was a retrospective view of toys and their impact on the participant's current lifestyle. The study's primary findings were that playing with toys as a kid influences the development of critical abilities and shapes our negative or positive perceptions of our childhood. The results revealed how important it is for toy designers to depend on academic studies and conduct their studies to produce compelling, high-quality toys.

Louhapensang, 2019, researched to understand the factors that are significant to the design of toys for children aged 0-3 years, including development, child behaviour, and the characteristics of appropriate children's toys, including safety. The study looked at age-appropriate design criteria for children's toys. This study is a fusion of quantitative and qualitative research approaches. The research concluded that it was at a decent level, with an average value (x = 4.17, SD = 0.39), after monitoring behaviour from 80 children, synthesising the data for use in the design process, and assessing by the parents of 150 children. Compared to playing toy samples from Thailand's Toy Industry Association, a moderate degree of pleasure was discovered, with a mean of 3.42 (x = 3.41, SD = 0.61), and statistically significant at the 0.05 level in all categories. To summarise, toys for children aged 0 to 3 years, resulting from the research into three aspects of toy design: development and behaviour, playing ways, and safety, are key links between each other. Children's growth and conduct are consistent with play techniques because they impact the physical development of children by age, and toy safety in the design may prevent risk to children.

Loy, 2019 expressed that to develop children's procure higher ability characters, social advancement ascribes are need to install in children's' instructive toy plan. The researcher has checked on and talked about the significance of social abilities in preschool children's and announced that social improvement ascribes ought to be one of the contemplations and standards when planning an instructive toy. The social abilities of preschool kids are pivotal and huge and can be created through the utilization of play with specific kinds of instructive toys. From the surveys, the researcher recognized the significance of pretend in adding to the advancement of social abilities. This can be expressed that the plans of instructive toys which applied the utilization of imagine play are sable to urge the children to communicate the job they are envisioning while at the same time playing. Hence, this empowers the children to think and impart by executing their considerations while associating towards specific conditions. Simultaneously, social interactions among their companions within the same age group will be helpful to the improvement of their social abilities, also.

3.2 Design elements and cognitive development
Weisgram *et al.*, 2014 carried out a study to examine toy qualities and how they impact boys and girls' interests, stereotypes, and perceptions differently. In this study, 73 preschool children were included ranging from 3 to 5 years. In study 1, the researcher examined children's interests and

judgements of toys based on two essential characteristics: toy type and toy colour. In this experiment, children were presented with masculine toys and feminine toys manipulated to have a predominantly masculine colour scheme or a predominantly feminine colour scheme. In study 2, the researcher examined the role of explicit gender labels and toy colour on children's interests and judgments of novel toys. In this study 2, 42 preschool children were included ranging from 3-5 years. The children were presented with a novel item and were told that the item is either "for boys" or "for girls". The results indicated that girls' interests were significantly impacted by the verbal label given- toys labelled as "for girls" were rated as more attractive than toys labelled as "for boys". Colour also affected girls' interests. As in study 1, the colour pink did seem to permit girls to explore masculine toys. This indicates that pink may signify that it is allowable for girls to show interest in counter-stereotypic toys and activities. Further, the findings of children's perceptions of other boys' and other girls' interests parallel the analysis results of boys' and girls' interests. Children were more interested in familiar toys associated with their gender, and novel toys labelled as for their gender than in toys not associated with or labelled as for their gender. The study reported that colour was a particularly salient construct among girls. In both studies, it was clear that the colour of the toys had little effect on boys' interests and children's perceptions of boys' interests. It may be that regardless of the colour of the toys, boys will not cross the gender barrier into girls' domains (Kane, 2006; Twenge, 2001). However, feminine colours significantly increased girls' interest. Toys are labelled as for boys and increase the likelihood that these items will be categorized as "for girls." As we noted earlier, it is as if pink permits girls to venture in to the masculine toy domain by increasing their sense of belonging with those items.

Vaidya, 2021 [16], conducted a study to answer how children learn alphabets in pre-primary school and how they derive meaning from an educational toy designed for it. This study's observation and data collection were in two different pre-schools in Assam, India. Both pre-schools have about 60 children (ages 3 to 4) who regularly attend pre-school classes. Various toy design investigations are carried out throughout this project, with these children as the end-users. In this study, IDEO used a six-phase human-centric design approach in which end users constantly interact to gain insight and perception of a set of conditions. Over a month, four researchers conducted three observation sessions with pre-school children and instructors. Each observation period lasted around 25 to 30 minutes. The researchers concentrated on observing school children, instructors, the atmosphere, and the classroom tools. Furthermore, the researchers learned about teaching approaches for alphabets by conducting short unstructured interviews with school instructors. One of the study's concepts, which emerged during the observation phase, is to create shape-based toys for children with limited technical and financial resources. As a result, complex equipment setup, high-cost instruments, and specialised software toys are inappropriate for this pre-school target group. According to research, circular forms were significantly more common in shape learning resources than other geometrical shapes (circle is utilised in 93 per cent of books, 85 per cent of shape sorters, and 95 per cent of software programmes) (Resnick et al., 2016). Furthermore, Clements et al. (1999) and Verdine et al. (2016) found that

young children (3–6 years old and 2.5 years old, respectively) are considerably better at detecting circular geometry and significantly less precise in identifying other forms, according to their research. Thus, circular-shaped concepts are given priority in concept selection. According to the study's findings, the strategies utilised in chosen schools for learning the alphabet have been based on concepts such as object-image association and repetition, with children receiving feedback from the instructor or other pupils. The researcher also suggested that learning alphabets may be more successful by constructing shape-based educational toys that employ the same concepts of association and repetition and provide feedback via their form and physical qualities.

Brooker and Franklin, 2015 [15] aimed to investigate whether colour affects cognitive performance in 8 and 9-year-old children. In this study, children were given a set of tasks to perform in front of a different coloured screen and a grey screen. Further, performance was assessed for each colour relative to the grey baseline, and differences across colours were compared. The colours selected for the study were: red, green, yellow, blue, purple, orange, and a light blue and light red along with a mid-lightness grey. The study's findings suggested that colour can affect children's cognitive performance and that there is a detrimental effect of red.

Xia et al., 2016 [17] conducted a study to investigate the effect of colour on cognitive task performance. The difficulty of tasks was controlled in the first experiment to evaluate the effect of red and blue on detailed-oriented task performance. In contrast, the difficulty of tasks was manipulated in the second experiment to investigate the effect of red and blue on creative task performance. This study was conducted on 125 college students in China. Red improved performance on a simple detail-oriented assignment, according to the findings. On the other hand, Blue enhanced performance on challenging and simple creative activities and complex detail-oriented activities. Furthermore, the type and complexity of the task jointly alter the effect of colour on cognitive function, according to the research.

Olurinola and Tayo, 2015 aim to examine the effect of colour on the retention rate of graduate students. In this study, the researcher selected 30 graduates to participate in the study. The subjects were randomly allocated to three colour conditions: congruent, incongruent, or achromatic. The single-word reading list was delivered to respondents in achromatic, congruent, and incongruent colours. They had 10 minutes to study the words before collecting the papers with the list. After that, the participants were given a thirty-minute math task to deter them from rehearsing the words before being asked to recall them. The recollection test participants were then used as data. The study's findings demonstrated that colour impacted adult learners' retention. The researcher also indicated that the groups exposed to congruent colours and achromatic colours performed better than those exposed to incongruent colours.

4. Conclusion and Recommendations
The present study has reviewed and discussed the importance of educational toys and their design in children's development. From the results of the paper reviewed, it can be said that the use of educational toys in childhood can influence the development of different skills and shape the negative or positive view in childhood. However, it is essential to select age-appropriate educational toys so that the

toy's design can play its role effectively. Children can create new learning experiences through play; these self-created experiences allow them to acquire social, emotional, and intellectual skills that they would not acquire otherwise. Children's growth and behaviour are consistent with play methods because they affect the physical development of children by age. These factors in toy design make a toy effective.

Additionally, including social attributes in children's educational toys and child's play helps to improve their social abilities. The design elements in educational toys might help enhance their learning in children. Researchers suggested that colour has a significant effect on learning. Further, a study suggested that children differentiate their toys on two characteristics: toy type and toy colour. Their interest and judgment of toys vary with toy type, i.e. masculine and feminine, and toy colour, i.e. masculine colours scheme or feminine colour scheme. That means that colour also plays an essential role in child emotions which, if implemented in the design of educational toys, can motivate them in their learning. Thus, it can be said that colour can increase the sense of belongingness with different toy domains.

Similarly, the research could be explored to find the significance of design elements such as shape, form, and colour of educational toys in children's learning and how they can be incorporated in educational toys. However, there are dearths of research focusing on educational toys' design elements such as colour, form and shape. Further, researchers reported that colour affects the cognitive performance of children. Identifying the most effective colour that can enhance children's working memory performance, attention, and different cognitive tasks can help design an effective educational toy. Additionally, the effects of design elements on children's cognitive development can also be identified. The findings can be used as a background for designers and manufacturers while designing educational toys for children.

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