DESIGNING PLAY EQUIPMENT TO DEVELOP THE SOCIAL COMPETENCE OF CHILDREN WITH CEREBRAL PALSY

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ABSTRACT

This study investigated the design of play equipment for encouraging peer-to-peer social interactions amongst children with cerebral palsy aged from 4 to 6 years, as a means of developing their social competence. The focus was on developing a new conceptual model and criteria for designing this specialist play equipment and, thus, creating a level playing field for children with different manifestations of cerebral palsy.

According to the statistics of the National Health Service, it is estimated that approximately 1 in 400 children is born with cerebral palsy in the UK (NHS, 2017). It is recognised that these children often have reduced social engagement, yet socialisation plays a fundamental role in development. In spite of this, there are few toys specifically developed for children with cerebral palsy and even fewer which support peer socialisation. Therefore, there is a need to develop relational play equipment for them.

The research presented here is interdisciplinary and informed by a social perspective on disability. It combined theoretical investigation with design practice within an action-research approach. User-centred design was used for the design development and intervention. Observations of children with cerebral palsy and interviews with their parents and conductors were employed for collecting data about the children's social interactions before and during the design intervention in order to determine the effectiveness of the proposed concept. Data collection was carried out at the National Institute of Conductive Education in Birmingham, England.

A conceptual design model of play equipment for enhancing the social competence in children with cerebral palsy was developed. The model focused on designing semiotic content that could trigger cognitive, emotional, social and physical processes to encourage children to participate in relational play and facilitate peer-to-peer social interactions. Based on this model, design criteria were developed, integrating two interrelated sets of indicators. The first set pertained to the design position and comprised child-friendly design criteria. The second pertained to the social purpose, comprising indicators of social competence, such as social skills and self-confidence.

Based on these criteria, a number of design ideas were developed, using ideation, intuitive hand sketching and brainstorming. A final idea of the thematic play environment, "Undersea Friends", which corresponded best to the conceptual model of play equipment and met most of the design criteria and recommendations from parents and conductors, was chosen for the design intervention. "Undersea Friends" consists of the toys intended for practising particular social skills, where each toy in the play space is a creature-friend and a facilitator of children's interactions. These toys are Octopush Olly for practising turn taking, Hexapush Hetty for practising cooperation and Larry Long Legs for sharing. Two prototype toys for this environment were developed and evaluated with children with cerebral palsy for the purposes of this study.

This completed study highlights the difficulties which children with cerebral palsy may experience with peer interactions while playing. It provides a new understanding of the development of social competence through engaging children in relational play, facilitated by specialist play equipment, as well as the prototype toys of the play environment, "Undersea Friends". This research contributes to understanding of how designers can approach the creation of such play equipment by providing design criteria, design recommendations and suggestions for further investigation.

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1 INTRODUCTION

This thesis presents an investigation into designing play equipment for encouraging the peer-to-peer social interaction of children with cerebral palsy and for fostering the development of their social competence. The research investigated development of a new conceptual design model of play equipment, which engaged these children in playing with each other through use of the play objects during play sessions. This was seen to help in the creation of a level playing field for children with different manifestations of cerebral palsy by enabling them to develop their social skills more intuitively. This study focused on children from 4 to 6 years of age with a diagnosis of cerebral palsy.

The idea for this subject derived from my personal experience of having friends who have a child with this condition. I could see the challenges and opportunities this family met in their everyday life and understood that any improvement in the well-being of families who have children with this disability could lead to positive impacts on the economy and well-being of society in general. This led to the desire to apply my design knowledge and skills to dealing with this real-world, social issue.

The research carried out was of an interdisciplinary nature and integrated features from a number of areas, including child-centred design, inclusive design, emotion design, sensory design, sociology, psychology and education. The nature of this research placed it within the field of design for health and well-being.

Research projects on the development of children with cerebral palsy have to date mainly concentrated on physical and cognitive areas or on social development, pursued through special educational programmes and training (Elliot and Gresham, 1993). This study, in contrast, investigated how to foster the development of social competence through enabling these children to participate in relational peer play with a new model of play equipment. This specialist equipment allowed them to acquire necessary social skills through interactions within the system, child – play object – child. The equipment was not only a tool for fun, learning and development but more importantly an intrinsic centrepiece for attaining social competence. Throughout this study, the term, "social competence", refers to a child's ability to get along with and relate to other children (AEDC, 2011).

1.1 Problem Definition

Infantile cerebral palsy is the most common form of physical disability. Early intervention, development and sustaining healthy conditions for these children require a comprehensive and holistic approach. According to the statistics of the National Health Service (NHS, 2016), it is estimated that 1 in 400 babies born in the UK is affected by cerebral palsy and approximately 1800 children are diagnosed with the condition every year.

Cerebral palsy is one of the most common forms of physical disability amongst young children (Parkes *et al.*, 2001). Rozsahegyi (2014) examined a range of definitions and observed that available explanations of the condition are often medical in nature and focus on problems of motor coordination, balance and mobility, gross and fine movement, etc. As a result, support for these children is often also medical (Farrell, 2008; Hinchcliffe, 2007; Fox, 2003; Cogher *et al.*, 1992).

However, the picture of how cerebral palsy affects children's development is much broader than the medical model allows. A definition, developed by Bax *et al.* (2005, p.571 & 576), states that it is "a well-recognised neurodevelopmental condition beginning in early childhood and persisting through the lifespan", and that "the motor disorders of cerebral palsy are often accompanied by disturbances of sensation, cognition, communication, perception and/or behaviour”. This definition stresses that apart from effects on motor coordination, many other implications may also be present and impact upon development and learning. Therefore, the existing emphasis on the physical aspect of development for these children is not sufficient for improving their all-round development and their quality of life.

In Vygotsky’s socio-cultural view, disability, including cerebral palsy, is seen as a developmental disorder with two kinds of implications: primary – the neurological, biological impairment, and secondary – the social and cognitive implications which hinder the child’s participation in everyday activities (Vygotsky, 1978). The importance of this view is that the secondary implications make the child ‘disabled’. Vygotsky also stressed the importance of social interactions and stated that socialisation plays a significant role in a child’s development.

Doise & Palmonari (1984) and Lave & Wenger (1991) also drew attention to the importance of social interaction. They argued that social interactions and communication are critical components of development. According to the Department of Education (DfE, 2014), the fundamental outcome that needs to be achieved for many disabled children and young people is communication. Yet in spite of this recognition of the importance of social interactions, it is still an area which is insufficiently studied. From the above, the idea of addressing the social competence of these children, as an important prerequisite for their holistic development, was derived for this research.

As a group, children with cerebral palsy perform less well socially than do their peers with typical development (McConnell & Odom, 1999). According to Guralnick *et al.*

(1996), disabled children, including those with cerebral palsy, interact with peers less often and are less well accepted in comparison to typically developing children of similar ages.

Gaining the necessary social experience for disabled children if they are to develop their social competence can be a challenge due to a range of factors. For instance, social interactions with their peers do not always occur for them in the same way as for children with typical development; they are often overprotected by their parents; their social environment tends to consist mainly of adults (parents, therapists, doctors, etc.), which may limit communication with their peers; physical conditions may affect their ability to interact appropriately.

According to Erikson (1982), people develop socially through stages (Trust vs. Mistrust, Autonomy vs. Shame and Doubt, Initiative vs. Guilt, etc.) and each of the stages needs to be fulfilled in order to move to the next one. The factors, which may have an influence on the social development in children with cerebral palsy mentioned above, mean that the transitional stages of children's social development may have delays or gaps. Children who do not have a basic level of social competence by the age of six may have difficulties with relationships when they become adults (Ladd, 2000; Parker & Asher, 1987).

1.1.1 Play and the development of social competence in children with cerebral palsy

The following section considers play as an intrinsic means of gaining social skills and forming social competence in young children.

During the early years, a child's social competence evolves through the ability to separate from parents and engage with peers in shared play activities (Vahedi *et al.*, 2012). As young children are just learning to manage their social behaviour, their interactions are often short and marked by frequent quarrels, and friendships are less stable than at later developmental stages. During the preschool and primary-school years, children are mainly focused on group acceptance and having companions with whom they can play (AEDC, 2011), and the attainment of social relationships with peers is an important achievement for preschool children in particular (Guralnick, 2001). This social development is fundamental and also helps growth in other areas, such as physical, cognitive and emotional domains (see section 2.2). It is the focus of this study.

There are developmental stages which can be indicatively used to understand the main skills which children with typical development reach by a certain age. The early years are the most critical period for developing social skills (Guralnick, 2001); basic peer social skills for children with typical development are formed in the 3 to 5 age period (Parker & Asher, 1987).

In England, children start school in the year in which they have their fifth birthday. From 4 to 5 years they attend reception classes. Education activities in reception classes are based on the playing process, as being the most appropriate for children of this age range (DfE, 2014). Design interventions with play equipment in the early-years, Foundation-stage curriculum can be done in reception classes with minimum changes to the children's routines and can even become part of their established programme.

The development of children with cerebral palsy often differs qualitatively from that of non-disabled children at the same age and many of their stages may be reached later. Therefore, it is reasonable to target the age range for this study at 4-6 years, to include those who attend the first key stage of their primary education, as well as those in reception classes following the more play-based, Foundation curriculum.

The primary context for fostering the development of social competence in children is play interactions with family members and peers (Goldstein, 2012; Whitebread, 2012). During play, children are able to test out social behaviour and learn acceptable social rules. They learn how to get along with one another, be helpful and share, understand the consequences of their own behaviour, etc. (Pellegrini & Blatchford, 2000). They are stimulated to share, take turns, cooperate, consider others' perspectives and acquire self-control (Gagnon & Nagle, 2004). The opportunity to play and explore provides them with the ability to learn about, for instance, likenesses and differences, acceptance and understanding, and socialisation, all in a way that cannot be learnt through any other means. Therefore, without knowing, they participate fully in their own social development during play (Isenberg & Jalongo, 2006).

1.1.2 Play equipment for developing social competence in children with cerebral palsy

All children learn through play, but play does not come naturally to all children. Sometimes the right toy can spark enough interest to start something new. As part of the physical environment, toys have the ability to contribute to or hinder the child's developmental process.

There are very limited options on the market when it comes to toys which encourage social interactions and are specifically designed for children with cerebral palsy. The majority of toys available for disabled children are presumably intended to be used by those with cerebral palsy also, however they have not specifically been designed for the needs of such children. Children who have moderate and severe cerebral palsy may often experience difficulties when using the same toy as other children of the same age but with typical development. They may not be capable of the range and quality of motion, muscle coordination and dexterity that playing with a particular toy requires. So, what might seem like an appropriate toy for typically developing children might pose many limitations for a child with this condition. In fact, it can have an even greater impact in that an inability to play with a toy can lead to frustration for the child, as well as a lack of motivation and a general feeling of helplessness.

Designing toys that are appropriate for children with cerebral palsy can be challenging and requires a holistic approach. Most of the toys designed for children with cerebral palsy address only their physical and/or cognitive needs and predominantly encourage solitary play (discussed in section 2.3.4). However, their social needs should also be a concern for toy designers (Hassenzahl *et al.*, 2012).

The common term, "toy", meaning an object for children to play with (Toy, 2019), is used in this study along with the broader term, "play equipment". "Equipment" means the object or the set of objects which is used for an activity or for a particular purpose (Equipment, 2019). Thus, play equipment means the object or the set of objects which is used by children for their play and has a particular purpose (often educational or developmental). Play equipment may include toys, toy sets and playgrounds.

This research is focused on identifying the issues that must be taken into consideration when designing play equipment to encourage the development of social competence in children with cerebral palsy. Play equipment in this study is viewed not simply as a part of the physical environment or as a set of toys for these children to play with; rather, it is regarded as a means for engaging these children in peer interactions through the play objects.

1.2 Research question and methodological approach

As discussed in the previous section, play equipment in this study is regarded as a means of mediating social contact between children with cerebral palsy appropriate to their abilities. The subject of this thesis is, therefore, not just the design of play equipment itself, but also the way in which such equipment can encourage and initiate social interactions between these children. To this end the main research question is:

How can we design play equipment to develop peer-related social competence in children of 4 - 6 years with cerebral palsy?

In working towards an answer to this, four sub-questions emerged to be addressed consecutively. The sub-questions were as follows:

1. What are the features of social competence in children from 4 to 6 years with cerebral palsy?
2. How can play enable social interactions for these children?
3. How can play equipment engage children in relational play?
4. What are the criteria for designing play equipment which facilitates the development of social skills in young children with cerebral palsy?

The relationship between the components mentioned in these research sub-questions is presented in the diagram (see Figure 1.1), where play equipment facilitates social interactions through relational play, which in turn helps children with cerebral palsy to develop social skills and thus to gain social competence.

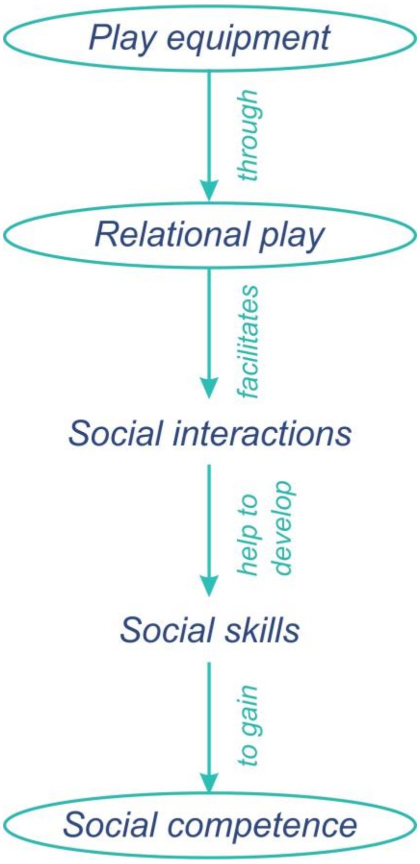


Figure 1.1. The relationship between components of the research question

Encouraging the peer-to-peer interaction of children with cerebral palsy can be a challenging aim and designing for this purpose and in this context demanded a complex methodological approach. To answer the main research question, this study combined theoretical investigation with design practice (Creswell & Plano Clark, 2011). The research strategy was modelled on an action-research approach (O’Brien, 2001). It was a practical research strategy, used to solve a problem and improve the way it is addressed (see section 3.2.3).

The concept of developing social competence through play served as a theoretical framework for the investigation, and from this a new conceptual design model of play equipment was created. The design model was primarily informed by the academic literature and observations of children with cerebral palsy. Data collection was carried out at the National Institute of Conductive Education in Birmingham, England. Initial observations were conducted to define the level and quality of the social interactions of these children before the design intervention. Based on the obtained data, design ideas of play equipment were then developed and two prototypes of the play equipment were created. Observations were carried out with the intervention in place, in order to determine any changes in the children's peer-to-peer interactions and consequently the effectiveness of the designed play equipment. The empirical part of this research also helped to evaluate the conceptual model of play equipment.

The play equipment designed in this study was intended to be used in special schools and nurseries for children with disabilities, in inclusive schools and nurseries and in centres of conductive education.

1.3 The structure of the thesis

This thesis consists of seven chapters. Figure 1.2 presents a visual description of the thesis structure.

Figure 1.2. Visual description of the thesis chapters

Following the Introduction (chapter 1), the Literature Review (chapter 2) outlines the main focal points of the study. It also examines the characteristics and connections between perspectives of the following elements, in order to define the context and the key concepts of the study: the development and learning of children with cerebral palsy; the development of social competence in preschool and primary-school age groups of these children; how these children play and what they might play with that could aid their social development; and child-friendly design approaches for designing play equipment. As the aim of this research was to foster the development of social competence in these children, the ways of using play equipment for this purpose were also investigated, supported by the analysis of examples from current design practice. Based on the above, the new design model of equipment for relational play was derived, as a basis for the design intervention.

In chapter 3, the design methodology framework to conduct this research is discussed and the rationale for choosing the methods and tools applied in designing the play equipment and for collecting and analysing data are formulated.

Chapters 4, 5 and 6 deal with the empirical part of this thesis. Chapter 4 presents the observations of children in their early years to understand the role of play equipment in their activities and social communication, their social abilities, the scope of their peer interactions, as well as the nature of their difficulties and the level of their independence. The chapter also discusses findings from the interviews with parents, which were carried out in order to gain insights into their children's favourite toys, their interactions with peers and adults and their desired toys or toys' properties.

Chapter 5 discusses the design intervention which included developing the play equipment, building prototypes and their installation at the National Institute of Conductive Education (NICE) in Birmingham.

Chapter 6 contains the second set of data collection in the form of children's observations and interviews with practitioners who were working with these children. This was done to discover any changes in the children's social interactions during the design intervention.

Chapter 7 assesses the findings of this research, including the success of the two prototypes in relation to the theoretical framework, and gives recommendations for future research in this field.

2 LITERATURE REVIEW

2.1 Introduction

This chapter outlines the context and the key concepts of the research. It focuses on the development of social competence in children with cerebral palsy through relational play, and intuitive engagement with others through play equipment. This review is used to develop a new conceptual design model of play equipment that facilitates participation in the process of peer-related social development through play. The new model is intended to shift the emphasis from limitation to potential of and benefit for these children. To understand the manifestations of cerebral palsy in children and to define a set of design criteria for developing play equipment, the chapter begins with an outline of the current status of medical and social views on cerebral palsy. The literature review then continues with a discussion regarding the importance of the development of social competence. Based on this, the chapter continues with the discussion about play and the necessity of understanding play equipment as a means for gaining the necessary social skills. The chapter ends with a definition of the design areas of this study and gives an outline of the design criteria required for creating a new model of play equipment. The conceptual framework of the research represented in the following diagram (Figure 2.1).

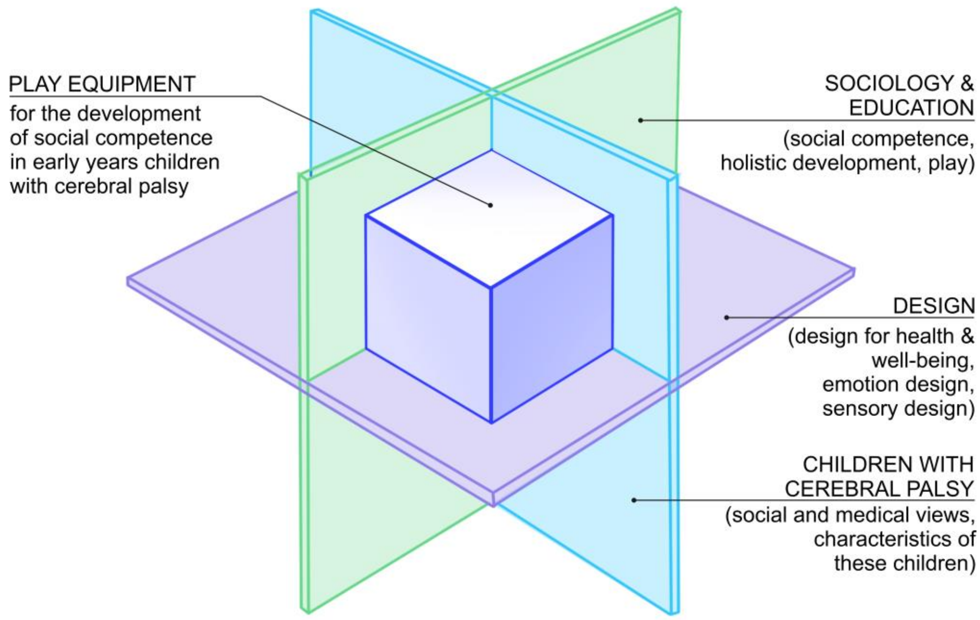


Figure 2.1. The conceptual framework of the research

2.2 Children with cerebral palsy and their social competence

Cerebral palsy is now generally considered as a non-progressive neuro-developmental condition that occurs in early childhood and is associated with motor impairment, usually affecting mobility and posture. Griffiths and Clegg (1988, p.11) defined cerebral palsy as:

> *a persistent but not unchanging disorder of posture and movement caused by damage to the developing nervous system, before or during birth or in the early months of infancy.*

Levitt (1982) explains that since the damage occurs in the developing nervous system, the clinical picture is not a complex of static symptoms. While the damage itself is not progressive, it has various and fluctuating manifestations throughout the maturation of the nervous system, and pathological symptoms which may develop later. Consequently, how children experience the implications of growing up with cerebral palsy is highly individual and unique to each person.

Whilst historically cerebral palsy was perceived as primarily a movement disorder caused by brain damage, more recently it has become an umbrella term used to define a group of permanent conditions, indicating that there is heterogeneity in these conditions such as visual, cognition, perceptual and/or behaviour, sensation problems and learning disabilities (Krageloh-Mann *et al.*, 2009).

2.2.1 A medical view on cerebral palsy

One of the key characteristics of cerebral palsy is its variability of presentation (Liptak & Accardo, 2004). Cerebral palsy ranges in severity, usually in correlation with the degree of injury and the area of the brain damaged. Because cerebral palsy is a group of conditions, signs and symptoms vary from one individual to the other. It is a complex condition, impacting all-round development differently in different children.

The primary signs of cerebral palsy are muscle spasms, difficulties with gross and fine motor functions, balance, control, coordination, reflexes, and posture, swallowing and feeding difficulties, dribbling, speech impairment, and poor facial muscle tone, etc (NHS, 2017).

Because of the variability of impairments caused by cerebral palsy, it is important to have a reliable classification of this condition. Traditional methods of classification have focused on topographical distribution, severity, and type of movement disorder (Rosenbaum *et al.,* 2006).

Topographical distribution classifies children based on the distribution of involvement of the limbs of the body (visually presented in Figure 2.2). The most common descriptive terms used are monoplegia, hemiplegia, diplegia and quadriplegia (Delgado and Albright, 2003).

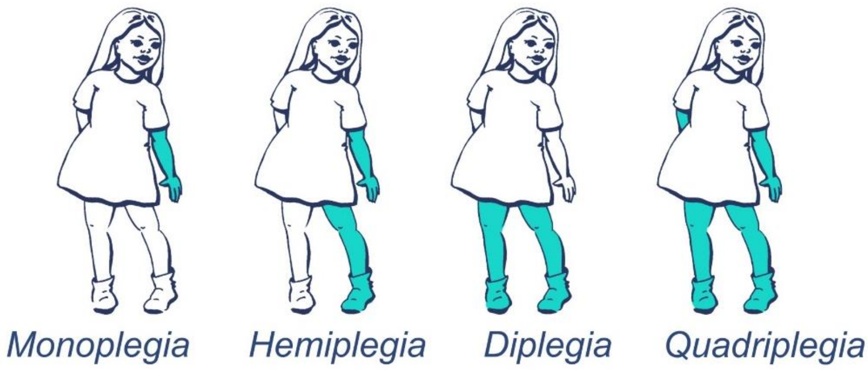


Figure 2.2. Classification of cerebral palsy based on topographical distribution

Blair and Stanley (1997) have developed a system that delineates the categories as follows: predominantly spastic (80% of cerebral palsy population), predominantly athetoid (10%), predominantly dystonic (5%), ataxic (2.5%), and mixed (2.5%).

Spastic cerebral palsy is characterized by muscle tightness and contractions, joint stiffness, rigidity and hypertonia (Dzienkowski *et al.*, 1996). Spasticity typically affects certain muscles more than others. Uncontrolled, fragmented movements involving the extremities as well as facial and oral musculature are a distinguishing attribute of athetoid cerebral palsy (Hammond, 1871). Differentiating characteristics of dystonic cerebral palsy are slow, twisting, repetitive, uncontrolled movements of extremities (Sanger *et al.*, 2003). Ataxic cerebral palsy is characterized by low tone, tremors, imprecise motor movements and shakiness (O'Reilly & Field, 2019). Mixed-type cerebral palsy includes persons demonstrating characteristics or behaviours from two or more of the categories listed above.

Classification based on the severity of symptoms uses the terms such as mild, moderate and severe to describe the degree of motor impairment (Blair and Stanley, 1985).

The above categories indicate the variability of the characteristics of cerebral palsy and show the resulting difficulty in defining the type of this condition. But it should be noted that while the brain damage will not worsen over time the physical manifestations can change and can either improve or deteriorate depending on the type of intervention experienced.

These classifications consider cerebral palsy from the medical perspective and distinguish different types of the condition primarily based on physical implications. The medical perspective of cerebral palsy focuses on problems of motor coordination, balance and mobility, gross and fine movement, combined with cognitive and perceptual difficulties (Cogher *et al.*, 1992; Fox, 2003; Farrell, 2008; Hinchcliffe, 2007). Such a view advocates a professional physio-therapeutic means of rehabilitation and development to compensate for the impact of cerebral palsy (Rozsahegyi, 2014), as this is easy to observe and measure in all patients.

Although there is no standard therapy that works for all children with cerebral palsy, some of the therapies used to help these children include: physical therapy, occupational therapy, botulinum toxin, speech therapy, behavioural therapy, drugs used to control seizures and muscle spasms, special braces or orthotics, orthopaedic surgery to correct contractures or improve function, etc. (CHASA, 2016).

However, even if the motor abilities of the child increase, the psychological distress and the lack of social engagement may not necessarily decrease (Parkes, 2008; Landsman, 2006; Landsman, 2005).

The two main models necessary for understanding this disability are medical (discussed in this section) and social. The next section discusses the social aspect of cerebral palsy and highlights the importance of emotional and social areas of development, alongside the physical area.

2.2.2 The social aspect of cerebral palsy

While the physio-therapeutic support of children with cerebral palsy remains dominant in the United Kingdom, Rozsahegyi (2014) has argued that such an approach encourages only the child's passive participation and emphasizes dysfunction, rather than focussing on a child's abilities. Hári and Ákos, 1988; Hári, 1997 and Sutton, 2010 cited in Rozsahegyi (2014) stress the significance of the emotional, social and cognitive implications which the child faces as the result of a neurological condition and the ways in which these difficulties could be overcome.

According to Vygotsky (1929), disabled children are not limited by defects nor are they less developed in comparison to their non-disabled peers, but they develop differently. The personality of a disabled child is something special and not the sum of any "defects" or "limitations". Moreover, any defect creates incentives for compensation (Stern 1923 cited in Vygotsky 1929). This does not only mean physical compensation, but also psychological.

The positive difference of disabled children is created not because of a lack of certain functions that a child with typical development has, but because this lack triggers a unique personal reaction to the disability and a unique compensatory mechanism. Therefore, in contrast to Piaget's theory about common, universal stages and content of development (Piaget 1959), Vygotsky argued that at each stage, a child (disabled or with typical development) represents a qualitatively different, particular type of development.

Vygotsky distinguished two kinds of implications for growing up with a disability: the primary or biological implications, and the secondary or social implications. He emphasised that it is the latter, which is important, because these will hinder the child in meeting the demands and expectations of society. These secondary implications are the focus of this research.

Vygotsky said that "every function in the child's development appears twice: first on the social level and later on the individual level; first, between people and then inside the child" (Vygotsky 1978, p.57). For example, initially child's gestures can be just movements without particular meaning. However, when people respond or react to the gestures, they become meaningful. Then, after the child comprehends, they can be used for social communication.

Vygotsky (1978, p.36) states that cognitive development stems from social interactions from guided learning within *"the zone of proximal development"*. The zone of proximal development is the difference between what a learner can do without help and what he or she can do with help. He believed that the role of education and social experience is *"to give children experiences that are within their zones of proximal development, thereby encouraging and advancing their individual learning"* (Vygotsky 1978, p.37). The number of skills, which can be developed through social guidance and collaboration, are usually wider than skills which can be developed alone (Fani & Ghaemi, 2011).

This study adopts Vygotsky's findings about the importance of fostering the development of social competence in children with cerebral palsy. It has investigated opportunities to find ways to help these children to become more independent and socially developed.

Rogoff (1990, 1998), based on the work of Vygotsky, also emphasised the social nature of children's all-round development. Further evidence supporting this idea can be found in the number of personal stories and experiences from people with cerebral palsy provided on the "My Child" website (2016). They show that it is important for disabled children to be included in society, and not to be treated differently or to be isolated. These stories indicate that social aspects play a vital role in the development of disabled children but that this is still not being addressed sufficiently.

Vygotsky (1978), Kozulin (1990) and Meadows (1993) argued that the development of a child arises from his/her attempts to deal with everyday problems and from interactions with their environment. Disabled children do not feel the disability itself; they feel difficulties caused by the disability. From this position, the disability is defined by the social and physical environment which may help or retard children's social development. The social and physical environments influence the developmental uniqueness of each child (Scherbina 1916, Burklen 1924 cited in Vygotsky, 1929). Compensatory processes are also socially determined and are directed at overcoming difficulties caused by the disability and not at overcoming the disability itself which is likely to be impossible.

The perspective discussed above allows looking at disability from the position of design in order to further understand the situation and to develop design interventions to ease the daily encounters of disabled children. There are several design approaches, such as inclusive design, accessible design, ability-based design, etc. which address difficulties caused by the disability (these approaches will be discussed later in sections 2.4.2 and 2.4.3).

Despite a diversity of views and definitions of cerebral palsy, the effects of it are clearly visible in children's lives, shaping their experiences and participation in social life (Rozsahegyi, 2014). In the following section the development of social competence in children with cerebral palsy is presented in more detail.

2.2.3 Social competence in children with cerebral palsy

"Social competence refers to a child's ability to get along with and relate to others" (AEDC 2011, p.2). Being socially competent involves many elements, including the ability to regulate emotions, develop a knowledge of social interaction through experience, and to respond appropriately to social situations and customs (Katz & McClellan, 1997).

For young children, social skills include learning to be a friend, to indicate personal needs and deal with difficulties, to be assertive without being aggressive and to relate effectively with adults and peers (Rolfe & Linke, 2011). For children, social competence also includes

> *knowing what is expected for social interactions, such as making eye contact, taking turns, listening to others, not being aggressive; "reading" other people's facial expressions and gestures; recognizing emotions in others and oneself; and being able to communicate effectively with others, including family members, peers, and adults. (2016, informational website "Happy Tots")*

Children, who are able to initiate play, enter ongoing play groups, appropriately respond to peers' initiations, and resolve conflicts with peers will also be socially competent in other aspects of peer relations (Howes & Matheson, 1992).

Social competence is interrelated with other areas of development and should be understood as being as important in young children's development as physical, emotional and cognitive development (Blandon *et al.*, 2010). Speech and language can be defined as either part of the above-mentioned developmental areas or as a separate fifth area of development. Current understanding considers children's development as holistic and consisting of these inter-dependent dimensions. Children's holistic learning and development *"involves all areas of development and embraces a view of the whole child developing in the context of family, home and community"* (NCCA, 2007).

In the case of children with cerebral palsy, if one area of development is impacted, then it will have implications for other areas too. Based on the above, the progress in one area affects the progress in other areas and if one area of development is strengthened, one can anticipate development in other areas. The development of social competence may advance emotional, cognitive and physical areas of development.

Disabled children have broadly the same aspirations in social acceptance as non-disabled children and the outcomes they would like to achieve are therefore similar (Scottish Government Social Research, 2013). The study by Stalker *et al.* (2010 in Scottish Government Social Research 2013, p.9) argues that

> *disabled children are, in most respects, the same as their non-disabled peers. They have a similar range of interests, aspirations, they want to access the opportunities and experiences open to non-disabled children (though with support as needed).*

However, for some children with cerebral palsy acquiring the skills and knowledge necessary for interacting positively and successfully with peers is a challenge. Disabled children tend to experience difficulties with peer acceptance, and their interactions may be qualitatively and quantitatively different and sometimes socially challenging (Odom, 2005). They may have difficulties in forming and maintaining relationships because physical manifestations of cerebral palsy may limit or restrict them from participating in everyday activities with their peers (Odom, 2005).

The combination of these factors can lead children with cerebral palsy to be at risk of developing mental health difficulties such as low self-esteem, and mental health disorders such as depression. Many of these children, therefore, would benefit from the help with bridging their differences and finding ways to learn from and enjoy the company of others.

2.3 Using play to foster the development of social competence

This section discusses the concept of play in the context of social development in children with cerebral palsy and argues that play is the primary activity for practising social skills which are necessary if these children are to be socially competent. The concept of relational play is introduced as a specific category in play theory which understands play as a means for creating social situations for interactions between peers through play equipment.

2.3.1 Play as a means for social competence development

"Play is the way children learn and is the child's equivalent of work" (Rogers, 2003, p.97). The importance of play within children's development has been validated by many researchers, including Moyles (1989), Anning (1991), Bruce (1991), Wood and Attfield (1996), Bennett *et al.* (1997), Sayeed and Guerin (2000). Vygotsky (1978) saw play as a zone of potential development, in which children operate at

their highest level of functioning, beyond their present-day possibilities. Play is also a highly satisfying, enjoyable experience which carries its own rewards.

Play is the primary context in which children build their emergent social communicative skills, as well as establishing their social competence (Mathieson & Banerjee, 2010; Craig-Unkefer & Kaiser, 2002; Zigler & Bishop-Josef, 2004). Using social communication in play allows children to satisfy their needs and desires, understand the behaviour of others, participate in a social exchange, express their opinions or feelings, engage in a fantasy, obtain information, and provide information to others (Craig-Unkefer & Kaiser 2002; Zigler & Bishop-Josef, 2004). Winnicott considered that play occurs at the intersection of self and others as a *"potential space"*, and it is a key to emotional and psychological well-being (Winnicott, 2005, pp.51-52).

Play is seen to be so important for children's development, that it is a universal right for all children under article 31 of the UNCRC (2013). Whilst playing, children can experience, respond and adapt to a wide variety of social situations (Gleave and Cole-Hamilton 2012, pp.10-13). According to Ellis (1973), play fosters the behavioural variability of the child. Conventionally and currently, leaders in theories of early childhood education see play as fostering well-being, creative thinking skills, cognitive and social skills (Piaget 1962; Frost & Sunderlin 1985).

Social play involves a high level of reciprocity and cooperation to work well and children learn about turn-taking, sharing, allowing others to go first, controlling emotions and putting the continuity of the play before their own immediate needs and wishes (Kay, 2007). All of these social communicative behaviours coalesce to form the child's capacity for social competence.

Interactions with peers during play are the main component of gaining social competence for early years children as they include a number of social skills. An overview of the main social skills acquired is presented in Figure 2.3. These social skills can be expressed by children in different ways, such as looking, talking, listening to others, smiling, touching and communicating by signs.

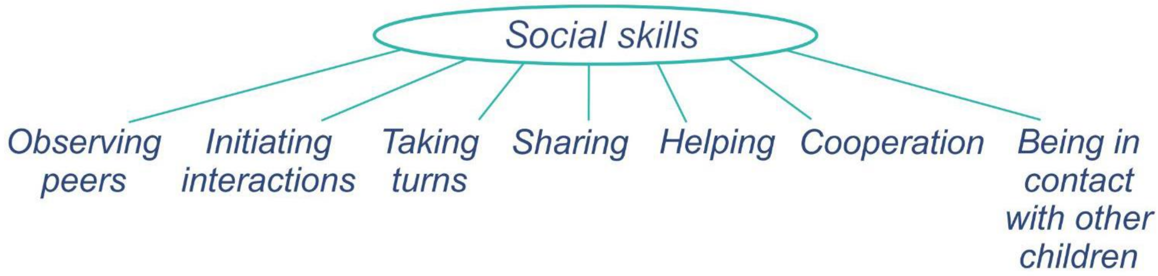


Figure 2.3. Social skills for early years children

Although most theories of play (Gleave and Cole-Hamilton, 2012; Winnicott, 2005; Mellou, 1994; Sutton-Smith, 1997; Frost & Sunderlin, 1985; Vygotsky, 1978; Piaget, 1962) assume that it is beneficial and imperative to children’s development and learning, there is a widespread debate regarding the magnitude of the benefits, and when these benefits occur during development. Despite the differences in views concerning the magnitude and occurrence of the benefits of play, it is generally assumed that play does have advantages and provides areas for children’s all-round growth, including social development.

Through play between and among children, they learn how to get along with one another, to be helpful, to share and to understand the consequences of their own behaviour, etc. (Pellegrini & Blatchford, 2000). Quality play builds confidence and reinforces a child's desire to explore and to learn. Therefore, without knowing, during play, children participate fully in their own social development (Isenberg & Jalongo, 2006).

2.3.2 Characteristics of play of children with cerebral palsy

Disabled children's play often qualitatively and quantitatively differs from that of their non-disabled peers. Play repertoires can be more limited, and play may occur less frequently in children with developmental disabilities (Li 1981, pp.121-126). Children with physical disabilities may find it hard to participate in games that their non-disabled peers play. Some children may find it difficult to approach their peers to engage in social and play activities. Specific aspects of play may be related to the type and severity of the disability (Kaplan-Snoff *et al.*, 1988). Disabled children may experience physical, cognitive, emotional, or social including communication difficulties or a combination of these.

Jennings *et al.* (1985) present the characteristics of play for children with physical disabilities, including those with cerebral palsy, as more solitary and less diverse. They suggest that these issues were noticeable when children had to structure their own activities by themselves. During adult-led tasks, disabled children behaved more like their non-disabled peers, but might be less persistent in their tasks.

While disabled children may experience play deficits due to their disability, such deficits may also be environmental in origin. Beckung & Hagberg (2002) have investigated activity limitations and participation restrictions with gross and fine motor functions for mobility, education and social relationships in children with cerebral palsy. They indicated that the effect of a child's impairment or activity limitation on participation might vary depending on environmental factors (Beckung and Hagberg 2002, pp.309-316). Environmental factors are defined as *"the physical, social and attitudinal environment in which people live and conduct their lives"* (WHO 2007, p.16).

Children develop an understanding of themselves through their interactions with events and materials outside themselves and with others within such environments. Hughes (2010) argues that children's development is directly linked to their ability to interact with their physical environment. According to Strain *et al.* (1986), the physical environment is a significant determining factor in the interpersonal communication of children. Environments have the ability to contribute or retard developmental process.

A supportive learning environment should be carefully planned to meet a child's needs by providing them with the optimum opportunities to work independently, to make choices, decisions and solve problems, to engage in real experiences and to experience success (Montessori, 2004). The physical environment is especially crucial for enabling a child's communication and play. Objects for play and access to peers are essential requirements for young children.

In summary, the reason of the difference between the play of disabled children and that of children with typical development, may be the lack of appropriate physical surroundings to play in. Children with cerebral palsy may simply need a suitable and accessible physical environment in which they can engage with play objects and initiate and sustain peer interactions. The environment should offer these children opportunities to actively explore surroundings, make decisions and follow through with their ideas, engage in different types of play and increase control over their bodies (Hohmann & Weikart, 1995).

2.3.3 Play types and the concept of relational play

In order to be able to design play equipment effectively, it is important to understand different play types. Play is varied and flexible and encompasses a large range of play types. Play can be active or subdued, imaginative or exploratory, involve others or be carried out alone. There are numerous classifications of types of play suggested by academics. Some of them focus on the character of play (Parten, 1932), others pay attention to the complexity of play (Caillois, 1961), on the number of participants or the play area (Gleave & Cole-Hamilton, 2012) and to the age appropriateness of play (Piaget, 1962).

Some useful categories to think of with regard to play include the following (Gleave & Cole-Hamilton, 2012):

- Play types according to play area are outdoor and indoor play; play at home and play in learning environment.
- Play types according to play participants are play with parents, play with siblings or other children, and play alone.
- Play types according to their characters are unstructured (open-ended) play and directed (structured) play.

Piaget (1962) defined three types of play, which develop in order. The first one is sensory-motor play, which involves the senses and movement. The second type is pretend or imaginative play during early childhood. Finally, there are games with rules.

Parten (1932) developed the stages of play from non-social to social. There are six stages:

- Unoccupied play (when a child is just observing);
- Solitary play (when children start to play on their own and do not show interest in other children);
- Onlooker play (when a child is looking at the others who are playing but does not engaged in the play);
- Parallel play (when children begin to play side-by-side with other children but without interactions);
- Associative play (when a child is interested in the other children playing but there is no coordination in their activities);
- Cooperative play (when a child is interested in both the children playing and the activity they are doing).

Caillois (1961) argues that the complexity of play can be described by four play forms and two play types. The play forms are agon (competition), alea (chance), mimicry or mimesis (role playing), and ilinx (vertigo). According to Caillois, these forms of play should be placed on a continuum from ludus to paidia, where ludus means structured activities and paidia means unstructured and spontaneous activities.

These classifications describe various aspects of play types while at the same time many classifications have similarities and overlap. This study considers play as a means for creating social situations for social interactions between peers, while the physical play environment facilitates these social situations. In order to investigate whether there is a separate category of play which focuses on peer to peer social interactions through play equipment, a combined categorisation of existent play types is presented to provide an overview. Figure 2.4 presents the newly developed combined categorisation of the existent play types.

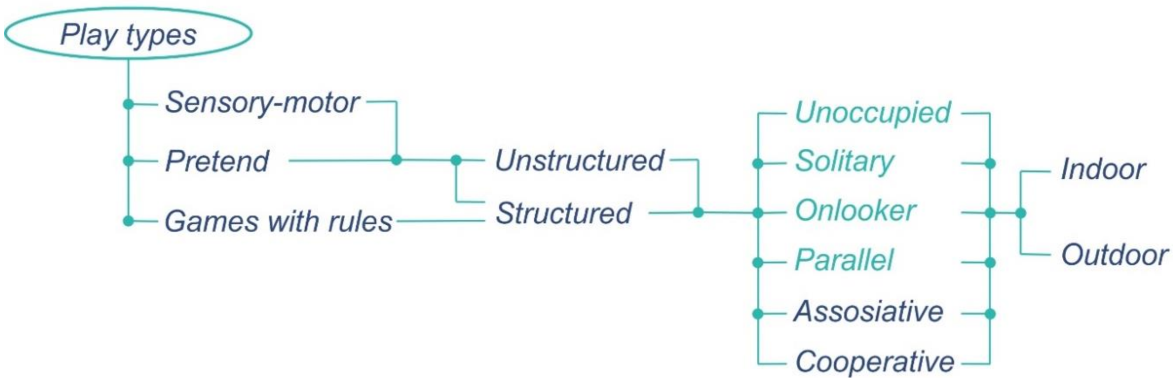


Figure 2.4. Combined categorisation of play types

This categorisation has identified play types in which children may develop social skills as defined in the previous section (Figure 2.3). Figure 2.5 shows these play types.

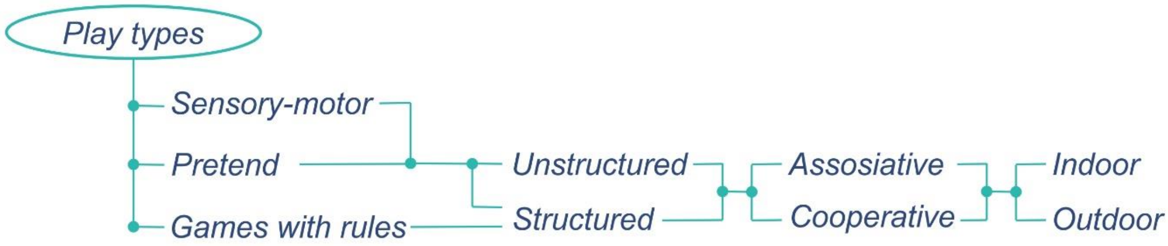


Figure 2.5. Play types which correlate with developing social skills

These play types allow social interactions but are not focused on them specifically. They also do not reflect the presence or absence of the play equipment used for a play, which is essential for this study. Therefore, it is worth defining a play type which would support the development of social competence in young children and the use of play equipment as a separate category.

The category of the form of play in which children participate in social interactions encouraged by their physical environment is called "relational play" for the purposes of this study. The term "relational" was inspired by the theory of relational aesthetics (Bourriaud, 2002). Bourriaud first used this term in the catalogue for the exhibition "Traffic" in 1996 to refer to interactive installations and events created to facilitate community among artists and viewers through collective experiences. He defined relational aesthetics as

> *a set of artistic practices which takes as their theoretical and practical point of departure the whole of human relations and their social context, rather than an independent and private space (Bourriaud 2002, p.113).*

The main idea of relational aesthetics within art is to create a physical space for realisation of a particular social situation. The user experience of this social situation becomes the artwork. In relational art, the audience is engaged in social interactions and is perceived as a community. The concept of relational aesthetics corresponds particularly well with the understanding of play in the context of the present study.

When applied to the context of play, it means to create a physical play environment to encourage the social interactions of children during their play, where play is a medium for the peer-to-peer interactions.

Before applying the notion "relational" to the play scenario, it is necessary to investigate the use and understanding of this name in the play-related literature. After some careful research a few references to the term "relational play" were found. Benson & Haith (2009) use this term to describe a type of play which occurs in infancy, when children bring together two unrelated toys to play with, for example a block and a car. However, more frequently in the academic literature such play is referred to as sensory-motor (from the above classification in Figure 2.5), exploratory play or functional play. Thibodeau (2019) used the term relational play to describe an activity when children aged between 1 – 2 years use an object for what it is meant to be used for, for example pushing a car around the floor. Although Thibodeau at first used the term relational play, she immediately replaced it by the term functional play which is more widely known in the literature. In the classification (presented in Figure 2.4) this play type could be placed under sensory-motor play. For this study, the term relational play refers to the child-to-child relations promoted by their play environment, not the child relating one toy to another.

In summary, the review of the available literature indicated that the concept of relational play has not yet been established as a specific category and that there is no systematic understanding of what relational play is. Therefore, the above discussion gives a rationale to adopt the concept of relational aesthetics to play theory. In the following, the term "relational play" will be referred to as the play type that facilitates the development of social competence in children through the play equipment.

2.4 Play equipment for relational play

Following up on the idea that children with cerebral palsy have similar aspirations in play as children with typical development, the differences in their play will have roots in their physical and social environments. From the design perspective, a designer can change, influence, and create the physical environment which should be supportive and enabling for these children. Therefore, the section starts with developing the conceptual design model of the play equipment for relational play. Then it discusses design approaches and principles of designing such play equipment for children with cerebral palsy. The section continues with the development of design criteria and analysis of the existent play equipment designed for disabled children, including those with cerebral palsy, against these criteria. Particular attention is paid to the toys which hold social function.

2.4.1 Conceptual design model development

The conceptualisation of play equipment as a means of developing social competence requires a designer to investigate the relationship between the design properties of the play equipment and the social activities performed by using this play equipment.

The concept of the play equipment in this research is based on the idea of object-centred sociality (Engeström, 2005; Simon, 2010), and seen as a trigger for initiating social interactions between children who are involved in the playing process. The main idea of object-centred sociality is that social links and relationships can be created not only between people, but between people and objects (Engeström, 2005). To develop the conceptual model of the proposed specialist play equipment as an agent for enabling social interactions, it is necessary to make a few assumptions to unpack and relate the design parameters of such play equipment.

The first assumption is that sociality consists of social subjects and social objects. This point of view was developed and described by Bliss (1917). Under social subjects one can consider individuals or groups of individuals. In the context of this study, children with cerebral palsy are implied as the social subjects and will be considered as the individuals within the group. The social objects here stand for the play equipment as part of the children's physical environment.

Rapoport (1977) suggested that the social subjects interact with the social objects during activities, where the activities are conditioned by the subjects' goals and guided by the social objects. The activities are a medium for the social objects and the social subjects which have their relationships and inter-dependencies, but also activities are a trigger of emerging interactions (Engestrom, 2005; Popov, 2009).

Therefore, the second assumption is that interactions between the social subjects and the social objects exist during activities. Popov (2009) developed this idea further and linked built environments with their inhabitants and users through their activities in these environments. The idea of activities in the context of this study is understood and limited to the playing process of children with the play equipment and the interactions between children, which occur during this process. Thus, the playing process can be seen as a medium for interactions between children and the play equipment, where the playing processes are guided by the children's goals, wishes, behaviours, overall development and supported by the play equipment. Thus, social interactions are considered as a part of the activities.

These assumptions promote linking all the components into a holistic system where the social objects, the social subjects, the activities and social interactions are interrelated and influence each other (presented in Figure 2.6).

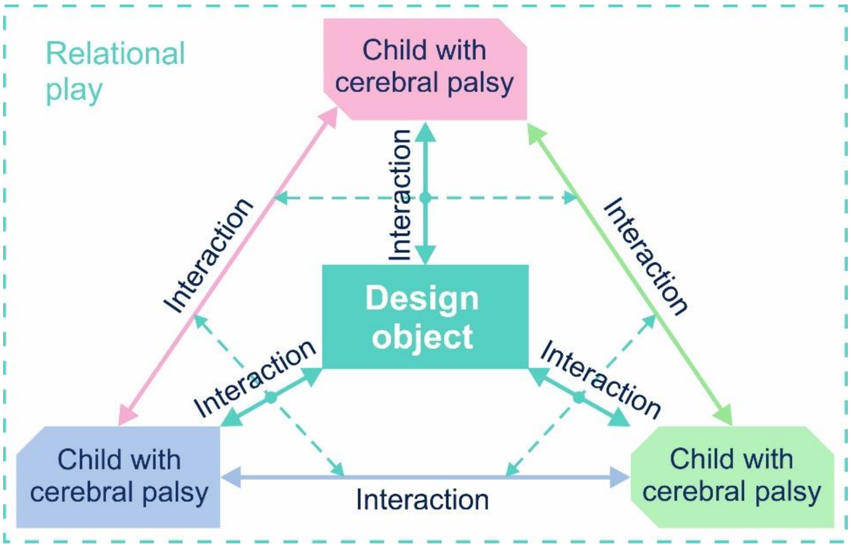


Figure 2.6. Interactions within a system 'child – object – child'

The triangular design model of relationships between person-object-person was discussed by Niedderer (2007), where the model links cognitive and emotional processes of communication with the designed object. Here the design model was adapted and supplemented by the medium where all the elements are linked. The interactions of children with play equipment (designed object) foster the interactions between children. Thus, play equipment can encourage peer interactions between children through relational play.

2.4.2 Designing for children with cerebral palsy

Designing for disabled children, including those with cerebral palsy, requires a complex approach. Currently, there are several design approaches focused on investigating and taking into consideration the diversity of children's abilities and requirements when designing for them.

These approaches include the following:

- Inclusive design,
- Accessible design,
- Ability-based design.

Accessible design, which focuses on a specific target user group (Heylighen *et al.* 2017), is also known as barrier-free design, which often uses adaptations and/or assistive technologies. It is often aimed at wheelchair users. Heylighen et al. (2017) also provides other examples of accessible design, such as 'ASC (Autistic Spectrum Conditions) friendly architecture', deaf space, dementia friendly environments, etc.

Basnak et al. (2015) consider accessible design as part of inclusive design, saying that inclusive design focuses on all users, particularly on disabled users and that both approaches are associated with accessibility and functionality.

Clarkson & Coleman (2015) and Pullin & Newell (2007), in contrast, present inclusive design as the opposite approach to accessible design, saying that while accessible design addresses the requirements of particular groups of users, inclusive design is looking for the match between these requirements with the needs of the entire population. Inclusive design aims to include an overlooked group of users but does not perceive this as a different type of design. This approach is committed to design for everyone in an equitable way, regardless of age, gender or disability (Coleman *et al.* 2003, Keates & Clarkson 2004, Mace 1991).

There are some challenges in the practical applicability of inclusive design, as creating design that corresponds to the needs of everyone is practically impossible.

The origins of these challenges may be rooted in controversies about the conceptual basis and consists in *"how we exclude inclusion from inclusive design and generalise/summarize the differences between individuals and groups"* (Luck, 2018).

Ability-based design, which emphasizes ability and makes it a central focus (Wobbrock *et al.* 2011), attempts to shift the focus of design for disabled people from disability to ability. It focuses on ability of the user throughout the design process and creates products which use the full range of users' potential (Wobbrock *et al.,* 2011).

Inclusive design, accessible design and ability-based design have differences and similarities. However, all three design approaches require a deep understanding of how certain groups of people interact with and experience designed products and physical environments.

This study investigates designing specialist play equipment for children with cerebral palsy aged from 4 to 6 years. The study attempts to shift the focus from disability to ability. It utilised characteristics of both inclusive design and ability-based design to do so. In this context inclusiveness means considering variability of presentations of cerebral palsy. Also, the research is focused on a particular user group, but does not exclude other potential users which are not considered in the frame of this study.

2.4.3 Principles of designing for children with cerebral palsy

The above-considered design approaches are based on design principles. For example, the Equality and Human Rights Commission established the following principles which form the foundation of inclusive design for play (Goodridge 2008):

- Ease of use. This means that the design product or play environment is easy to understand, regardless of the child's experience and skills.
- Freedom of choice and access to mainstream activities. This means that it is important to have independent access and if required to get assistance.
- Diversity and difference. It should be recognised that, for instance, children with cerebral palsy have different manifestations of this condition.
- Legibility and predictability. This means that the design communicates necessary information effectively to the child.
- Quality.
- Safety.

The Design Council (2006) provided seven principles of inclusive design as follows:

- Inclusive, which means that everyone can use the design safely and easily.
- Responsive, which means taking account of what users say they need.
- Flexible, which means that different users can use the design in different ways.
- Convenient, which means that everyone can use the design without too much effort.
- Accommodating for all users, regardless of their gender, mobility, ethnicity, etc.
- Welcoming, which means there are no disabling barriers that might exclude.
- Realistic, which means offering more than one solution to help balance user's needs.

Several authors have defined inclusive design requirements specific for designing play equipment appropriate for disabled children or for choosing existent ones. For example, Shusterman (2011) added to the above principles that the toys should attract the child's attention. Gascoyne (2012) noted that an inclusive way of encouraging play and development is sensory-rich play equipment.

Based on the above discussion, it is possible to summarise the child-friendly criteria which play equipment for children with cerebral palsy should adhere to (presented in Figure 2.7).

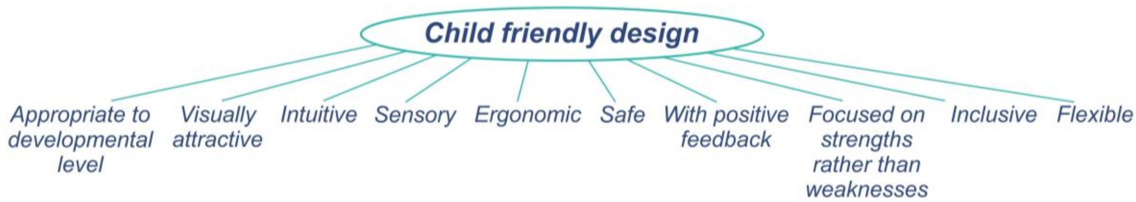


Figure 2.7. Child-friendly design criteria of play equipment for children with cerebral palsy

The description of each criterion is provided in Table 2.1.

Table 2.1. Child-friendly design criteria

Appropriateness to developmental level	Play equipment intended for younger than the target group children can be uninteresting to them, while equipment for older children can be too complicated. This may lead to inability to play with the play equipment provided and to loss of interest.
Attractiveness	Play equipment should be visually attractive (colour, form, visual image, materials, etc.), as visual perception is dominant among all the human perceptual activities (Myers, 1989). Play equipment with an attractive visual image is more engaging. It can also contribute to keeping a child's attention for longer.
Intuitiveness	Ease of use and intuitive use allow children to focus on what they want to do instead of how, and to play with the play equipment maximally and independently with minimal help and guidelines from adults.
Multi-sensory	Playing with sensory-rich play equipment encourages learning and development which is appealing to children with different thinking and learning styles (Gascoyne, 2012).
Ergonomic	Play equipment should be ergonomic and correspond to child's anthropometry (Goloborodko, 2012). Anthropometric data helps to evaluate the fit between children, play equipment and the physical environment. An understanding of this fit is critical to ensure that children can use play equipment intended for them. It protects them from harm by ensuring that hazards are properly guarded or placed out of reach.
Safe	Play equipment should be safe for reducing the potential for injuries. A list of essential safety requirements is set out in the Toys (Safety) Regulations 2011.
With positive feedback	Play equipment should have positive feedback to motivate children to continue the current task, reach new results and try new activities. It can stimulate and prolong play and raise self-confidence.
Focused on strengths rather than weaknesses	It is one of the main criteria in order to shift the perception of disability as a limitation to a more positive understanding. Children see and perceive the outer world in their own way and adapt to it depending on their abilities.
Inclusiveness	Play equipment should be engaging, stimulating and accessible for all children with cerebral palsy in the chosen age group.
Flexibility	Besides its main function, play equipment should provide opportunities to be used in different ways depending on the children's needs.

2.4.4 Design criteria of play equipment to aid the development of social competence

To design play equipment for children that facilitates their social development, an additional set of design criteria is required. Based on the analysis of the related literature it was possible to identify characteristics which play equipment should embrace in the context of promoting social development.

Design criteria are represented as a scheme with two levels (Figure 2.8). The first level comprises indicators from the design position (child-friendly design criteria were discussed in the previous section and presented in Figure 2.7), and the second one - indicators of purpose (discussed in section 2.3.1 and presented in Figure 2.3). The levels are interrelated and implementation of the criteria from the second level depends on the realisation of the first level's criteria.

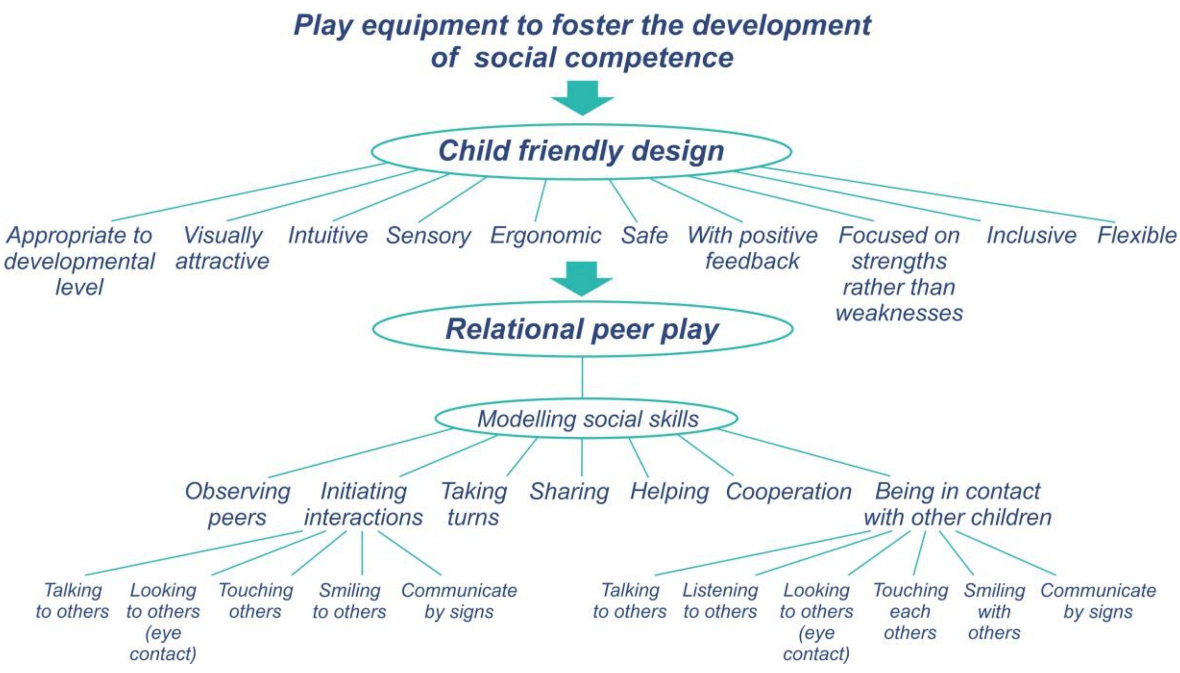


Figure 2.8. Design criteria

At the top of the scheme is play equipment which should have a child-friendly design to be engaging – the first level of criteria. Child-friendly design means that equipment should be intuitive, sensory, visually attractive, developmentally appropriate, with positive feedback, focused on strengths, ergonomic, inclusive, flexible and safe. Through child-friendly design, play equipment can empower children to participate in relational peer play, during which children are led by the equipment to practise social skills. Social competence involves a range of skills and refers to the smooth sequential use of these skills in an effort to establish an ongoing social interaction. The main social skills that early years children should develop competence in, include the following: sharing, cooperation, taking turns, helping, initiating interactions, making contact with other children. These social skills are criteria of the second level.

The next section presents a discussion and analysis of the existent play equipment relevant for social development against these criteria.

2.4.5 Play equipment as a means of peer-engagement

Play objects used in children's play, for children either with typical development or disabled children, are no less important than the game itself. Children have their own particular relationships with objects. Play equipment provides a means by which children can represent or express their feelings, concerns, or preoccupying interests. For children an unfamiliar object tends to set up a chain of exploration, familiarisation, and eventual understanding, and often a repeated sequence that will eventually lead to more mature conceptions of the properties (shape, texture, size) of the physical world (Garvey, 1977). Objects represent a mediating element between a child and his/her world. They also may help a child to explore what they can do and what their limitations are, thus contributing to the development of their self-image. Play equipment may cater to specific areas of development or preference and can serve as a therapy aid for a child with cerebral palsy (Hoffman *et. al*, 2014). For this study it was important to understand which toys for disabled children address their social development.

The same piece of play equipment can often be used by children with typical development as well as by children with cerebral palsy and based on the investigation of today's market there are no clear borders between them. Often, according to the toy market, the only difference in the use of certain play objects is the age range and level of physical and cognitive development. Therefore, despite the variety of play equipment which manufacturers position as for disabled children, finding toys which are appropriate for a child with cerebral palsy can be challenging due to their size, weight, texture or functions. Children with more complex manifestations of cerebral palsy may experience difficulties with producing the range of motion, muscle coordination, and dexterity that playing with these toys may require. Consequently, children who do not have the physical or cognitive proficiency to play with the play object provided may become bored or uninterested because of the lack of success. So, what might seem like a 'normal', 'simple enough' toy for children without developmental difficulties, might pose obstacles for a child with cerebral palsy.

From a wide range of play equipment available for disabled children, this study is most interested in the play equipment which perform social function and are intended for the use by two or more individuals simultaneously, in other words, the play equipment which encourage relational play.

2.4.5.1 Traditional social toys

Researchers have found that some types of toys may be more conducive to social communications and group play than others (Elmore et al. 2011; Ivory and McCollum 1999; Martin et al. 1991). In their studies, toys promoting social behaviour are typically identified as "social toys" and toys encouraging more solitary play are called "isolate toys". Isolate toys identified by most studies include puzzles, Play-Doh, books and art materials, while social toys include balls, dress-up clothes, housekeeping toys, blocks, puppets, and toy cars or trucks (Elmore et al. 2011; Driscoll and Carter 2009, Kim et al. 2003, Ivory and McCollum 1999; Martin et al. 1991).

Kim et al. (2003), Elmore & Vail (2011) and Martin et al. (1991) investigated the influence of social and isolate toys on the social interactions of preschool children with different abilities during free play. They discovered that disabled children were engaged in social behaviours more often when there were social toys present to play with and play groups included both disabled children and children with typical development. These studies concluded that selection of toys can be seen as a nonintrusive method of promoting social interactions. Ivory & McCollum (1999) also explored the effect of isolate and social toys on play of young disabled children in an inclusive setting. They reported that parallel play was the most common type of play for the children. Cooperative play did not occur often but was more likely when social toys were available, which is consistent with the studies discussed above.

In contrast, O'Gorman Hughes and Carter (2002) did not find clear and consistent evidence of higher levels of social interactions during children's play with either social or isolate toys. The results of the study by Driscoll and Carter (2009) indicated a modest influence of social toys on social interactions, with evidence of variation of this effect across disabled children.

There is no coherence among the researchers as to whether social toys (as defined in the mentioned above studies) have an influence on the frequency and quality of social interactions between disabled children, and if there is any, to what extent. The observed social interactions during children's play with social toys may be credited to the social skills which children already have rather than to the stimuli of the toys as they allow relational play but do not trigger it. Looking particularly at children with cerebral palsy, the toys in most of the cases should be adapted physically to allow them to play effectively. As was discussed earlier children often have involuntary movements, difficulties with motor skills, tremors, etc. that may complicate their play with for example balls, dress-up clothes, toy vehicles or puppets. Their attention may be more focused on physical efforts to hold/manipulate these toys than on social communication with their peers. Also, playing with dress-up clothes, housekeeping toys, blocks, puppets, and toy cars does not require two or more children to play together but can be played by one child alone. Analysing social toys against the design criteria developed earlier and presented in figure 2.8, the toys do not possess many of them. For example, none of the toys enable feedback, they may facilitate practising social skills only if played in a particular way (when pretend play happens between two or more children) that depends on whether children are socially skilled or not. Thus, there is still a need for toys which facilitate children's social interactions with minimal intrusion of adults, and which enable children to practise social skills.

Both isolate and social toys are used at NICE. Examples of social toys used at NICE are presented in Figure 2.9. These toys are usually used in the structured play activities guided by adults. In this case the toys perform their social function and children can practice social skills. The use of toys in children's play at NICE are discussed in more details in section 4.4.3.

Figure 2.9. Examples of the social toys used at NICE where a) balls, b) a doll, c) toy cars and a track, d) a kitchen toy (housekeeping toy), e) blocks

2.4.5.2 Social interactive robots

The next category of toys positioned for social development are social interactive robots. Interactive robots are used by therapists and teachers as tools to teach social and other life skills, for instance, recognizing emotions, crossing the road, imitating movements. They were identified as potentially useful tools to enhance the development of social skills in children with autistic spectrum conditions (ASC) who prefer interactions with computerized systems (Robins et al. 2005, Francis et al. 2019).

Kozima and Yano (2001) developed a robot that can maintain joint attention with a human and suggested that children with ASC could play and possibly learn social interaction skills through this robot. Fasel et al. (2002) used robotic systems to investigate the development of shared attention in toddlers with ASC. Michaud and Theberge-Turmel (2002) investigated how different designs of robots (an elephant robot, a spherical robot and a robot with arms and a tail) could engage children with ASC in playful interactions. Kozima et al. (2005) developed a robot with the appearance of a creature and reported that the robot provoked spontaneous play in children with ASC and the emergence of social communication with the robot. Robins et al. (2005) reported that a small humanoid robot can facilitate joint attention as a step to communicative and social behaviours of children with ASC.

All the studies mentioned above presented some positive results in engaging children with ASC in simple interactive activities with the robots. The aim of these activities was to encourage basic communication and social interaction skills. The use of robots provided a simplified and predictable environment, where the frequency and complexity of the interaction can be controlled (this is particularly important for children with ASC). However, it is not yet clear whether any of the social interactions that the children demonstrated during play with the robots would have any lasting effect and whether children could apply these skills in their everyday life and in the interactions with their peers in particular. Social interactive robots mainly encourage child-robot interactions, while this study focuses on peer interactions mediated by toys. Toys should not replace peer communication but should facilitate it.

Although not robots, two interactive toys for children with ASC and a bracelet-type interactive device which encourage relational play were found. They were selected through a purposive internet search. Design criteria from section 2.4.4 guided the choice. While the toys may not possess all of the criteria, they require two or more children to play with, engage players in relational play, and encourage the practising of social skills.

The first toy is the Gobug interactive toy (see Figure 2.10) developed by Katz and Rim (2011). Two to three children can play with this toy simultaneously together. Every user takes ownership of a single controller. While each user points his/her remote in a particular direction, the Gobug moves around in the combined direction of active controllers. The more these controllers are in synchrony, the faster the Gobug moves in the same guided direction. Gobug will activate only when two or more controllers are in-hand.

Figure 2.10. Gobug interactive toy. Source: http://www.core77.com/posts/19262/autism-connects-gobug-interactive-toy-19262 (with permission to use)

As mentioned earlier, this toy was not designed for children with cerebral palsy nor for young children. Gobug is positioned as a toy for school age children on the autism spectrum. Thus, while the toy is designed to facilitate social interaction and collaboration, it does not take into account the physical and cognitive needs of children with cerebral palsy. The Gobug looks like a creature – a bug, which makes it attractive and emotionally appealing. The toy enables feedback which is elicited by collaborative actions of the players.

Another example is a Toy for touch developed by Dsouza et al. (2019). This toy (shown in Figure 2.11) was also designed for children with autism. It should be worn on the hands of two players. When the players walk towards each other the toy lights up and blinks quickly. When they walk away from each other the lights grow dimmer. The feedback is triggered only when players touch each other's hands, one hand triggers vibration and the other hand triggers a melody.

Figure 2.11. Toy for touch created for children with autism. Source: http://www.divms.uiowa.edu/~hourcade/idc2012-specialneeds/dsouza.pdf (with permission to use)

The toy for touch is multi-sensory, as it produces sound, vibration and is made from a soft fabric. It provides feedback on the actions from players in the form of a blinking light and gives a feedback reward when the players touch each other's hands. This toy was designed for children with ASC and does not take into account physical needs of children with cerebral palsy.

The third example is a bracelet-type wearable device EnhancedTouch developed by Iida et al. (2016) for facilitating physical touch. EnhancedTouch (presented in Figure 2.12) can measure human-human touch cases and provide light as visual feedback to increase touch interactions. Moreover, it offers a function to record the time and duration of a touch event as well as the identity of the touched person.

Figure 2.12. Wearable device EnhancedTouch. Source: http://dl.acm.org/citation.cfm?id=2858439 (with permission to use)

This device potentially can be used by children with cerebral palsy to encourage physical touch. EnhancedTouch has a Velcro fastening that makes it easy to wear. It gives feedback when hands touch, but there are no hints about how to use the bracelet for playing. Children may need initial instructions on what is the aim of play with this device.

The toys presented above require two or more children to be played with, they can engage players in relational play, and encourage practising social skills. They also have many of the design criteria from section 2.4.4. Although these toys were not designed for children with cerebral palsy, they can serve as an inspiration for the design stage of this study with regard to their social criteria.

2.4.5.3 Playgrounds

Playgrounds are spaces designed especially for children to play in, which provide children with opportunities for physical and social activities. While playing in a playground, children can learn social norms and values (Stagnetti, 2004), therefore playgrounds can be an example of play equipment which perform social function.

Prellwitz and Skär (2007) investigated how children with different abilities, including children with cerebral palsy, use playgrounds to engage in play and interact with their peers. Twenty children with different abilities participated in their study. The results showed similarities and differences in experiences. The similarities were that: all the children knew in detail the playgrounds where they play; they see playgrounds as a place for activities with some sort of challenge and prefer play equipment with a recognisable design; the children perceive playgrounds as a place for private conversations with friends, away from adults (for the disabled children this was expressed rather as a wish or as something important that happened once or twice). Dissimilar experiences were the following: while children with typical development experience the playground as a meeting place with friends, disabled children were seldom with friends and never made new friends at the playground; for children with typical development play activities in the playground had names and usually involved others, for disabled children play activities had no names and their descriptions lacked social interactions; disabled children expressed that some playground equipment were challenging for them and they were afraid of using these in a wrong way.

The studies by Ripat and Becker (2012) and by Moore and Lynch (2015) explored disabled children’s experience of using playgrounds, and Rocha et al. (2018) evaluated the accessibility of playgrounds specifically for children with cerebral palsy from 4 to 6 years old. Data from their studies supported findings from the previously discussed research in terms of limited usability of playgrounds for disabled children, including a few playgrounds which were positioned as accessible. Rocha et al. (2018) observed that children who participated in the activities in the playground required the assistance of the teachers or caregivers.

Although playgrounds are places with social function, they are hardly accessible and usable for disabled children without the help from adults and seldomly support their interactions with peers if they were designed without an understanding of disability and the play activities. To address this issue, an increased attention has been given to creating or adapting playgrounds that facilitate participation and inclusion (Ripat & Becker, 2012). Accessible or inclusive playgrounds have been suggested to enable all children to play, socialize and be socially included through the way they are designed. Inclusive playgrounds aim to provide all children with greater opportunities to be physically active, socialize, play, and learn.

The study by Wenger et al. (2020) explored the experiences of playing in inclusive playgrounds of children with and without disabilities. Six inclusive playgrounds were selected and 32 children with different abilities, including children with cerebral palsy, participated. Inclusive playgrounds proved to have fewer barriers in the physical environment as compared to conventional playgrounds. For example, they have small adaptations, such as handrails or extended entries and exits on slides, a significant portion of the ground is concrete to facilitate the movement of children in wheelchairs, etc. Both children with and without disability often described the inclusive playgrounds as 'cool' and 'great'. The possibility to use the equipment on the inclusive playgrounds seem to strengthen the children's self-confidence.

Although inclusive playgrounds are accessible and usable, the study showed that there was hardly any contact between disabled children and children with typical development in the playgrounds. Children experienced their belonging to a specific place on the playground and their social interactions were only with children who have similar abilities. Disabled children more often participated in solitary play rather than in joint play activities. Wenger et al. suggested that the invisible physical, attitudinal, and social barriers to social interaction prevent children from playing together on inclusive playgrounds. There are could be many reasons why inclusive playgrounds do not fully facilitate social communications for disabled children, and one of the reasons could be that play equipment in the inclusive playgrounds allow social interactions, but do not trigger them. Therefore, this research is particularly interested in developing play equipment that will engage children in relational play and trigger social peer-interactions by means of this equipment.

Two examples of play equipment which can be part of playgrounds and which encourage relational play were found through a purposive search on the internet. As in the toy examples from the previous section, design criteria (developed in section 2.4.4) guided the choice.

One example is an interactive art installation - Montreal's "Musical Swings" (presented in Figure 2.13) designed by Andraos & Mongiat. The swings are supposed to be for shared use and develop certain social skills. The installation consists of a series of swings where each swing in motion sets off different musical notes. The idea of the installation is that swinging all together forms melodies. Certain musical harmonics can be composed through cooperation, so the users need to adjust to the actions of each other.

Figure 2.13. Montreal "Musical Swings". Source: https://www.mtl.org/en/what-to-do/festivals-and-events/21-balancoires-montreal (with permission to use)

This installation is colourful and has an illumination at night, which makes it visually attractive and engaging. It invites people to a sharing activity and fosters cooperation by providing sound feedback on the swinging. Thus, the feedback from the swings plays the role of a trigger for adjusting the actions of the users and their cooperation. However, the swings do not require joint use and can be utilized independently. Also, they are not physically appropriate for children with cerebral palsy.

The next toy is a concept of a Seesaw (presented in Figure 2.14) developed by Chernyshev. It was designed for children with cerebral palsy and supposes joint use by two children. The seesaw has a specially developed chair shape with safety elements. Depending on the level of development, some children will be able to move it themselves by swinging their legs or tilting their bodies back and forth, while others may need assistance from an adult standing by and setting it in motion.

Figure 2.14. Seesaw for children with cerebral palsy. Source: http://www.coroflot.com/kerenrelin/design-for-children (with permission to use)

The positive aspect here is that this Seesaw supports cooperation and the making of eye contact with the other child – two of the main skills of social competence. It has assisting facilities designed especially for children with cerebral palsy which make it ergonomically appropriate and safe. However, there are also weaknesses, such as the lack of visual attractiveness (dull colours, visual image doesn't look much fun) with which to engage a child. Also, children with moderate and severe manifestations of cerebral palsy may find it challenging to use the seesaw without the help of the adult, where not being able to propel themselves might disempower them.

Play equipment can initiate, mediate or recreate social interactions. This can help to reduce barriers when becoming part of community and offer opportunities in developing the social competence of children. Notwithstanding, there is a limited choice of this type of play equipment at present.

2.5 Design theories to implement the design criteria

This section presents the discussion of relevant design theories that underpin the design development and the design criteria implementation. These theories offer support in creating more suitable design solutions for engaging children with cerebral palsy into peer interactions and relational play. The discussion of the relevant design theories allows for a drawing of conclusions necessary for the development of new design ideas and as a basis for further practical investigation and implementation.

2.5.1 Affordances of play equipment

Designing play equipment which facilitate the development of social competence is a complex task. Children play with a variety of things and their actions during play are not necessarily predictable. Sutton-Smith (1986, p.38) observed that

> *it is dangerous to pretend we know what a child will do with a toy just from its characteristics alone; children have a way of doing things with toys over and beyond the apparent character of the toy.*

Although, children may create their own play meanings with toys, and play with them in unexpected ways, toy designers should create affordances for playing.

The concept of affordances developed by Gibson (1979) denotes the action possibilities of the environment. He argued that users perceive the environment based on affordances or in other words on the behaviours that this environment affords. From this, it is possible to say that play environments for children are not only physical in nature but rather promote functional meaning that allows for certain play behaviours. Norman (1988) applied the concept of affordances to the design area and defined it as the action potential of an artefact. According to him, affordances guide users in what to do with an artefact and what possibilities it offers.

Play affordances define not only possibilities for actions but have a potential to play the role of invitations to these actions. Affordances as invitations were discussed by Withagen *et al.* (2012). Affordances make certain actions with an object more likely to occur. For example, a handle on the door suggests that you pull it to open, while the absence of the handle invites users to push the door. In toy design, it is really important to create and emphasize play affordances that invite children into play and solicit certain play activities. Utilising inviting play affordances in toy design may help to create toys which are attractive for children, encourage children to use these toys more frequently, trigger certain activities and contribute to a variety of children's play.

To invite children to play with the designed toys, play affordances should match their abilities and increase their motivation to play. These include features of the objects embedded within design, characteristics of the users and the context of use (Prieske *et al.* 2015). Withagen *et al.* (2012) and Prieske *et al.* (2015) explored physical action capabilities of the body as a factor that influences inviting play affordances. The physical capabilities of the body are a significant consideration when designing for children with cerebral palsy. Action capabilities determine not only if children can perform an activity but also the effort necessary to do it.

This factor can be considered as part of the broader issue – developmental appropriateness which combines cognitive, emotional and social characteristics of children along with physical capabilities. For example, play equipment intended for those younger than the target group children can be boring and uninteresting, while equipment for older children can be too complicated. This may lead to an inability to play with the play equipment provided and to a loss of interest. Moreover, it may lead to passivity in playing in general. Designing play equipment appropriate to the developmental level is difficult to implement because of the developmental difference of children with cerebral palsy even in the same age group. The way to overcome this is by creating open-ended play equipment without functional fixedness. The relationship between physical and behavioural factors and the interpretation of behavioural factors into the physical principles of design are determined by ergonomics (Lueder & Rice, 2008), which will be discussed in the next section.

2.5.2 Ergonomics of play equipment

This section discusses the ergonomic parameters needed to design play equipment for which children will be the main users. To design play equipment for children with cerebral palsy and to ensure that interactions with this equipment are comfortable, conducive and safe, ergonomic principles should be applied (Lueder & Rice, 2008). The ergonomic consideration begins with defining the necessary anthropometric measurements of children and the information on how children will interact with the play equipment.

The first category of parameters is anthropometry (Goloborodko, 2012) which can be static or functional. Static anthropometry is used to ensure that the play equipment is physically fit to be used by the children. It includes measurement of the body dimensions while the body is in static posture, such as: weight, centre of gravity, stature, hand and foot dimensions. The main dimensions are presented in Figure 2.15.

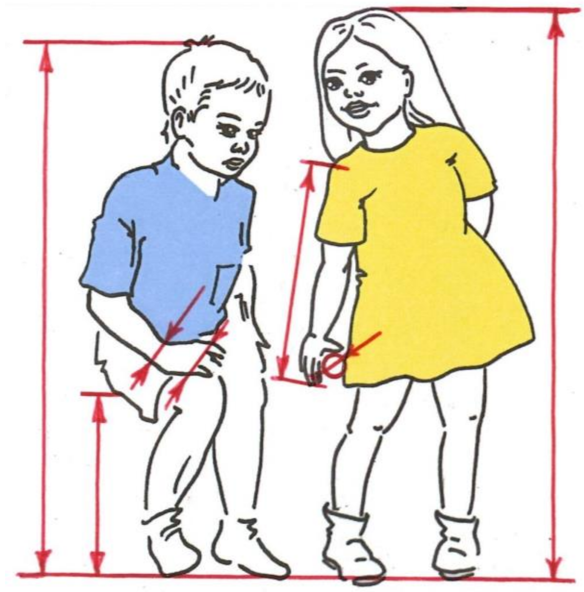


Figure 2.15. Static anthropometry measurements

Functional anthropometry is about the limits of the body movement. It includes: the distance that can be reached by a child in front of, to the side, or above of the body. Examples of the functional anthropometry measurements are shown in Figure 2.16.

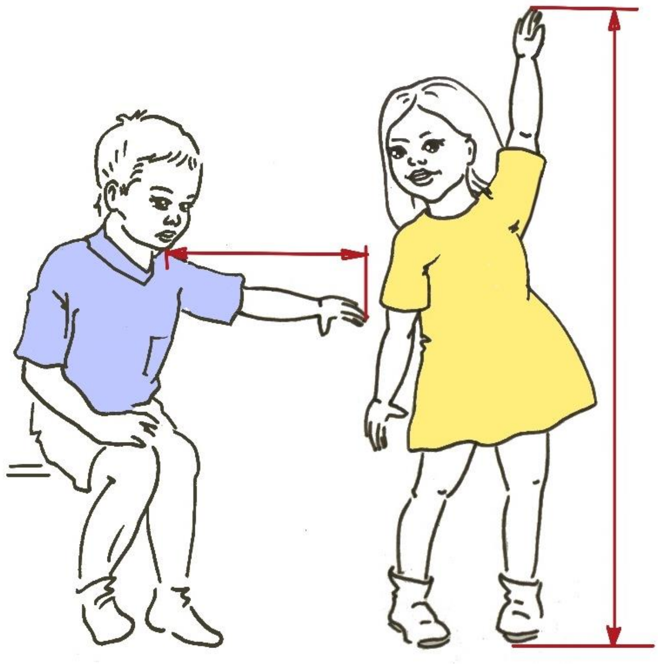


Figure 2.16. Functional anthropometry measurements

Anthropometric data helps to evaluate the fit between children, play equipment and physical environment. An understanding of this fit is critical to ensure that children can use the play equipment intended for them. It protects them from harm by ensuring that hazards are properly guarded or placed out of reach. Evaluation of the possible risks and injury scenarios connected with the use of the play equipment is discussed in detail in section 5.7.

The second category is physical abilities (CHILDATA, 2002) and includes measurements of the physical activity, such as strengths, movement and specific performance. The challenge in defining these parameters for children with cerebral palsy is because of variability in the presentation of this condition. The manifestations may vary from one child to another. The most common of them are difficulties with fine and gross motor function, maintaining balance and coordination, involuntary movements and impairment of muscle tone (NHS, 2017). All these must be taken into consideration in design.

The third category is psychological abilities which may include information about how children perceive the world and how they process information. The perceptual abilities include measurements of children's visual and auditory perception and reaction time to stimuli (Goloborodko 2012).

Designing play equipment for children is a complex task because the equipment must meet the children's current development, and also push them into their next level (Lueder & Rice, 2008; Bandri, 2016). Moreover, children grow and change rapidly, which means that the designer needs to understand and accommodate children's developmental stages and growth patterns and takes into consideration the individual differences between children. Body proportions can also vary between the sexes during childhood. Since the toy needs to accommodate a range of children, data must be carefully examined to set the design limits.

Anthropometric data and performance measurements are generally conducted on children without any form of disability (Goloborodko 2012). It means that anthropometric data from the majority of sources may not necessary accommodate children with cerebral palsy. To develop play equipment, the designer's task is therefore to address this inadequacy and to take into account variations that may occur in the specific cases. The other way to overcome this absence in research is to avoid specific tasks or specific parts in designing play equipment which requires knowing the precise dimensions. Further discussion of ergonomic parameters presented in section 5.5.5 where they will be applied in the design process of the play equipment.

2.5.3 Semantics of play equipment

Product semantics was introduced and defined by Krippendorff and Butter (1984, pp.4-9) as "*the study of symbolic qualities of man-made forms in the context of their use*". From this definition, product semantics imply the relationship between the user and the design objects, and also the importance that these objects hold in the context of their use. All design objects give a message and communicate with users through their shape, form, colour, texture, material, etc. Designers send messages through the objects via semantic communication structures. Being familiar with the semantic language, designers should know what message they want to convey to the user and what corresponding reaction or response they expect from the user. Semantics provide the way of communication with a clear message through the design object.

The semantic functions should make the product understandable and intuitive. The concept of the intuitive use of objects was studied by Blackler *et al.* (2007). She formulated a definition:

> *Intuitive use of products involves utilising knowledge gained through other experience(s). Therefore, products that people use intuitively are those with features they have encountered before. Intuitive interaction is fast and generally non-conscious, so people may be unable to explain how they made decisions during intuitive interaction.*

Intuitive use will allow children to play with play equipment independently with minimal help and guidelines from adults.

Intuitiveness is especially significant when designing play equipment for disabled children as it may allow them to feel more confident, allow them to accept the equipment and minimize rejection. The whole play equipment and its individual parts should communicate and transfer a message, so that children as users know how it should be utilized. In this case children can focus on what they want to do instead of how, with minimal help from adults.

Product semantics in the context of this study is about designing a meaning for the play equipment in order to communicate and deliver a message from the designer to the children as users through this equipment and make the process of perception more intuitive. The relationships between the play equipment, its meaning and the children who interpret this can be explored through semiotics, which will be discussed in the next section.

2.5.4 Semiotics in designing play equipment

Semiotics is the study of signs, and through them, it studies the origins of meaning in different languages of communication (Saussure, 1983; Eco, 1976). In design, semiotics allows the understanding of the relationships between signs, their meaning and people who interpret them - the users. Semiotics can build a link between form/visual image of the design object and making the meanings.

Simon (1982) introduced the idea that the design object acts as an interface, while the interface is the meeting place between two different entities that are supposed to come into contact. It has the nature of a sign by means of which people communicate. If signs are the mediating entity and semiotics is the theory and practice of mediation, design can be seen as a medium between two or several distinct entities. The concept of the designed object as the interface was also considered by Nadin (1990). He sees the design object as the reality through which user and designer communicate.

This idea was developed further by Kazmierczak (2003, p.45). She shifts the design paradigm *"from the preoccupation with designing objects for certain uses to focusing on the cognitive processes that underlie the reception of those designs"* by focusing on meaning. By stressing the cognitive nature of the design object's mediation, she approaches the design object as a trigger and as an interface for meaning-making. Perceptions of the design object and triggered thoughts in the user's mind cause the user to respond to the design object in a certain way.

Children are resourceful meaning-makers and any objects can become a potential resource in their *"semiotic work"* (Kress 1997, p.31). Pillows can be arranged to make a car, a tissue box can be transformed into a shopping basket, and so on (Stein, 2003). These selections are not random. They were not the only options, but they were selected as the most appropriate from those readily to hand.

> *From a range of possible alternatives, certain ordinary household items were chosen for their shape, size, texture, colour, containment, pliability, linkage and so on (Mavers 2007, pp.155-157).*

According to Vygotsky (1978), meaning potentiality is not unlimited. A stick might make a good horse, but it may not fit for a flute. Children connect certain meanings with certain carefully chosen material objects in response to the immediate focus of their interest. In this context, semiotics helps not to take reality for granted as something that simply exists. This supports the concept that reality depends not only on the intentions of the designer but the interpretation of the users who experience designed object.

Children as meaning-makers select resources that are socially, culturally and materially available and give them particular meanings. Halliday (2005) explains meaning-making as a social practice and presents social semiotics. Social semiotics stems from the premise that signs are always situated within various contexts of social processes and social relations where meaning is represented. This may suggest the necessity of understanding the social context in which children interact with design objects and its influence on their meaning-making. Also, the ways of meaning-making determine specific social situations and social relations where this meaning is presented.

While designing play equipment for social development, it is practically impossible to create form, appearance, etc. that would directly perform a function within a chlld's social development. But if we consider design as an interface for meaning-making, then the task of a designer is to construct semiotic content that triggers the cognitive processes of a receiver (children with cerebral palsy) of the intended perception of the design object (play equipment). In the context of this research, it means creating a desire to interact with the designed play equipment and then to build social interactions through using this equipment.

The process of interpreting and decoding the unfamiliar semiotic content involves two different reactions (Griffin, 1999). The first one is based on knowledge and dependent on social and cultural background, and the second reaction is emotional. The discussion of emotion theories is provided in the following sections, which will be used as background, inspiration and input into the design process for creating play equipment for children with cerebral palsy.

2.5.5 Designing emotions

Emotion theory has had an immense growth during the end of the last century (Scherer, 2002), it includes various areas such as physiology, psychology, neuroscience, genetics, etc., but describing all aspects of emotion theory is not of interest here. However, Desmet's and Norman's theories of emotional design can be particularly helpful in the context of designing play equipment that will help children to trigger social responses.

Desmet (2002) investigated how product appearance evokes emotions and proposed that appraisal theory can be used to explain how products elicit emotions. A product appraisal is an automatic assessment of the effect of a product on one's well-being. Desmet proposed four main types of product appraisals: the relation of a product to one's goals, the sensorial appeal of the product, the legitimacy of an action represented by the product, and the novelty of the product.

Norman (2004) also focused on the mental processing that gives rise to affective responses. He identified three levels of processing: a visceral level governing response through direct perception (design for appearance), a behavioural level involving learnt but automatic affective responses (design for ease of use), and a reflective level involving affective responses due to conscious thinking (design for reflective meaning).

The main limitation of the discussed approaches is that they focus on generalised pleasure. They do not differentiate experience beyond the basic positive-negative distinction. However, the emotional responses are not just pleasant or unpleasant experiences. They are a complex concept consisting of an expression, arousal, action tendency and subjective feelings (Weerdesteijn *et al.*, 2005). Therefore, a design object can be seen not only as a stimulus for evoking emotions, but as the object that initiates and influences emotional response, action, expression and arousal (Weerdesteijn *et al.*, 2005).

These theories of emotional design were used on two different levels of the design process, and for different purposes (see section 5.5.4). Firstly, to evoke interest and attract the children to start using the play equipment provided. Secondly, to trigger positive emotions while playing with it, as such positive responses are prerequisite for developing successful social interactions (Denham, 2006). The next section discusses the relationship between emotions and social competence in more detail.

2.5.6 Emotions and social competence

Emotions serve communicative and social functions. They provide information about peers' thoughts, intentions, coordinating social encounters and are considered important for social interactions (Lopes & Salovey, 2005). The expression of positive and negative emotions by young children often plays a significant role in building social interactions with peers (Denham, 2006). The expression of positive emotions usually enables interactions to happen and relationships to form as they attract others. Negative emotions can be important in signalling to other children what is not acceptable, for example pushing or hitting others. However, more often the expression of negative emotions or the inability to understand a social partner's emotions may complicate the development of social relationships (Denham, 2006). Children who often perceive emotions incorrectly and act in accordance with these misconceptions may be rejected by their peers (Darling-Churchill & Lippman, 2016).

Positive emotions help children to engage in new activities and varied social environments. Harker & Keltner (2001) said that joy and happiness motivate social interactions and play, while interest motivates exploration of the physical environment. Positive emotions can strengthen social cooperativeness and reduce conflict situations in the group. Therefore, they encourage the development of social relationships (Fischer & Manstead, 2008).

Although the literature suggests various emotions which can serve as basic emotions for children (Ekman and Friesen, 1971; Plutchik, 1980; Frijda, 1986), based on the above discussion, the emphasis for this study is on positive emotions. Positive emotions, such as happiness and surprise from the traditional list of basic emotions from Ekman (1972) are supplemented by joy from Ekman and Friesen (1971).

Designing play equipment with desired emotions for children with cerebral palsy is a challenging but important task for designers. In the context of designing for children, play equipment should initiate positive emotional arousal and response in children and lead to certain actions and expressions to make a positive ground for social interactions and relational peer play. The practical application of the emotion theories in designing play equipment is considered in section 5.5.4.

The next section discusses multi-sensory design approach as a means to communicate product semantics, attract children and keep their interest during playing with the play equipment, and trigger positive emotional responses.

2.5.7 Multi-sensory design

Children perceive and retain the most information when they engage their senses (Arnheim, 1974; Piaget & Inhelder, 2000). The sensory process starts when stimuli from the play equipment appeal to any of the five senses (sight, touch, hearing, smell and taste) or give some sensory response in case of cause-and-effect toys. Play equipment usually appeal to multiple senses, for instance, though sight and touch, though sight and sound, etc.

Sensory-rich play is an inclusive way of encouraging learning and development, with the hands-on approach appealing to children with different thinking and learning styles (Gascoyne, 2012). For disabled children, the detail of colour, texture, form, sound and lighting can have a much greater impact, depending on their disability. These things can be a source of discomfort and pleasure, as well as information, entertainment, education and reward (Bishop, 2012). These characteristics are considered on the basis of lights, sounds and texture. Smell and taste are not utilised in this study because the perception of these characteristics is highly individualised and can hardly be applied to a group of children.

Visual perception is dominant among all the human perceptual activities (Myers, 1989). It relies on different visual properties, such as colour, size, form, etc. Visual perception of design objects is a crucial aspect for emotional engagement (Stern & Robinson, 1994). However, children and adults perceive visual information differently. Adults process a whole visual image of an object as one unified block of information, while children under twelve years perceive different parts of the visual image separately from each other (Pappas, 2010). Also, young children prefer abstract images and more often express positive reactions to images depicting bright colours and familiar subjects (Savva, 2016).

No less important sensorial stimulus is touch which has such properties as pressure, temperature, hardness, weight, etc. Touch can be active and passive, where passive touch can perceive temperature and pressure, and active touch can recognize properties, such as shape, size and texture (Gibson, 1962). Touch is an important sense for feeling pleasure (Ackerman, 1990). Some design objects can be perceived as pleasurable and some as not, depending on their possible influence on the physical and psychological state. For instance, feeling pleasure directs children to come closer to an object they interact with.

The perception of varied sensory stimuli (visual, sound, tactile) triggers emotions (Rodaway, 1994). Although, these sensory stimuli function differently, they should be considered cohesively in order to induce the desired emotions (Uğur, 2013). Also, the stimuli should not remain constant all the time, as our senses better monitor changing sensory input. If a sensation remains the same, after a short period of time, depending on which sense children are dealing with, they may stop perceiving it. Thus, sensory stimuli of the play equipment should change in order to stimulate interest and alertness, and to keep children's attention for longer. The practical application of multi-sensory approach in design process is presented in section 5.5.3.

2.6 Conclusion

This chapter outlined the context and the key concepts regarding the development of social competence in children with cerebral palsy through relational play and their engagement in the play through play equipment. To understand the development and learning characteristics of children with this condition, the discussion began with the conception of cerebral palsy and an outline of the current status of medical and social views on cerebral palsy. This discussion showed that the social model is more focused on children's abilities rather than their disabilities as in the medical model, and stresses the importance of social and emotional development, along with physical. Analysis of Vygotsky's theory about the social and biological implications of disability and the zone of proximal development provided opportunities to find ways of helping these children in their social development from the design position.

This was followed by the discussion of play and play types in the context of their social development which revealed the gap in the existent play classifications and showed that there is no separate category of play where children participate in peer-to-peer interactions encouraged by their physical play environment. Thus, the concept of relational play was introduced as a play type which facilitates the development of social competence in children through play objects.

The overview of available play equipment for social development of disabled children presented in today’s market showed that although there is a lot of play equipment which manufacturers consider as being suitable for disabled children, it is often a challenging task to find toys which in size, weight, texture, function, etc. actually meet the needs and developmental level of children with cerebral palsy and perform their social function. Therefore, there is a need for research on the design of play equipment which encourage interactions between children and engage them in relational play.

To this end, a conceptual design model of play equipment was developed. It is based on the idea of object-centred sociality and can be seen as a triangulated design model of relationships between children with cerebral palsy, play equipment and interactions of these children through this equipment, where all the components are interrelated. To design play equipment in accordance with this design model, it was necessary to define a set of design criteria which would allow this play equipment to be child-friendly and to perform its main function of engendering social development.

Based on the principles of designing for disabled children and the key requirements in selecting toys for these children, the design criteria of play equipment were determined. According to the criteria, play equipment should have a child-friendly design to empower children to participate in relational peer play, during which children are led by the equipment to practise social skills. The design criteria consist of two interrelated levels. The first level includes criteria of child-friendly design (equipment should be intuitive, sensory, visually attractive, developmentally appropriate, with positive feedback, focused on strengths, ergonomic, inclusive, flexible and safe) and the second level includes the main social skills that early years children should develop competence in (sharing, cooperation, taking turns, helping, initiating interactions and making contact with other children). These criteria constitute the framework for the designing and development of the prototypes of play equipment which facilitate interactions between children with cerebral palsy.

3 DEVELOPING AN INTERDISCIPLINARY CHILD-FRIENDLY METHODOLOGY

3.1 Introduction

This chapter discusses the design methodological framework and methods developed for the four main stages of the research, including the conceptual design model development, the data collection before the design intervention, the design development and the data collection with the design intervention, and their rationale. It presents the methodological issues, such as research approach, data collection and analysis methods, ethical considerations, design methods and strategies that underpin the research, and strategies implemented to strengthen the study.

3.2 Research approach

3.2.1 Methodological positionality

This study combines theoretical investigation with design practice (Creswell & Plano Clark, 2011) in order to find an answer to the research question "How can we design play equipment which will develop peer-related social competence in children of 4 - 6 years with cerebral palsy?". The dual position of both researcher and designer taken during this study allowed for the gaining of insights into design practice and to use of design perspective as a means of looking for creative and child-friendly solutions, which were explored and demonstrated through the practice. Design practice became a tool of changing an existing situation into a desired situation (Simon, 1988), a tool through which new understandings were gained and constituted an important part of the methodology.

The role of design practice for this study can be defined as research *through* design, where the problem is investigated through the practice, or, in other words, practice-led research. Design practice in this study was an integral part of the research process (Candy, 2006). This allowed for an investigation into a complex and multidimensional topic that required the consideration of a range of the components within a system. Here the social objects (play equipment), the social subjects (children with cerebral palsy), the activities (relational play) and social interactions (peer to peer interactions as part of the social competence) were interrelated and while still having their own requirements to be considered.

Design practice was used as a method of generating new knowledge important to that practice and contributed to how the research question was answered. It also played a role as a means of communication for the research and as a means of engagement of the children into the developmental process of their social competence.

3.2.2 The methodological framework

Based on the above discussion, from a philosophical perspective, the design research methodology lies within the critical paradigm, which not only allows for the problem to be explored theoretically, but also to identify ways to create actual change (Horkheimer, 1982) for the purpose of positive social change. To facilitate such change, this study explored the development of social competence in children with cerebral palsy and proposed to address this through creating specialist play equipment which engages children in relational play and, thus, in social interactions.

Design methodology is context dependent and corresponds to the following criteria of contextualism (Bohman, 2005):

- The study explains what is wrong with the current social reality (discussed in section 2.2),
- It identifies action for change (discussed in sections 2.3, 2.4),
- It provides clear norms for criticism and transformation (discussed in sections 2.2.1, 2.2.2).

Based on the above, the methodological framework of this research could be constructed, comprising all the components of the research and their relationships, and guiding how to conduct the research (Niedderer, 2013). The methodological framework can therefore be presented in the form of the following diagram (Figure 3.1), adopted from the paper by Niedderer (2013, p.9).

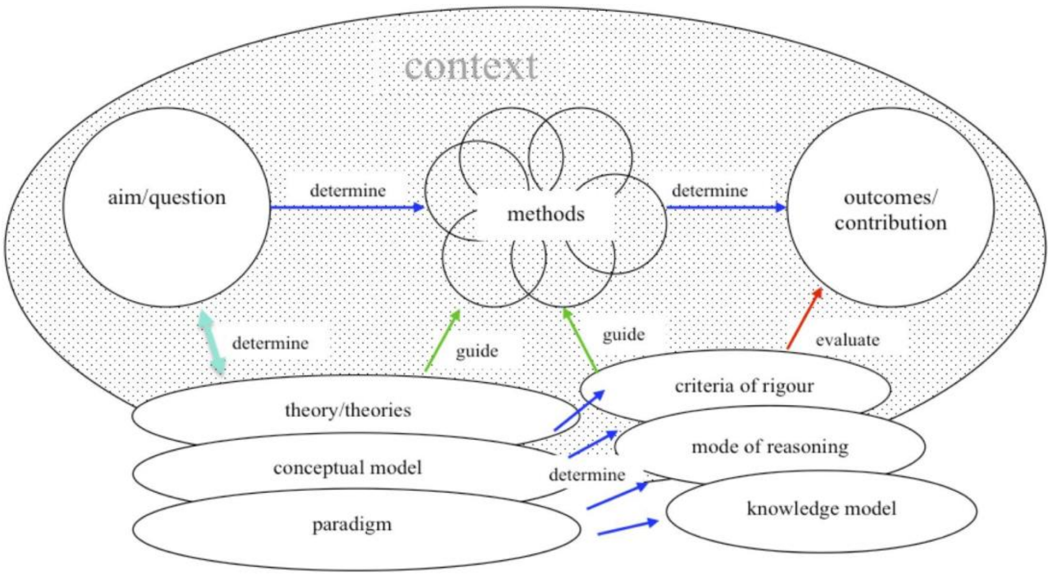


Figure 3.1. The methodological framework from Niedderer (2013, p.9)

This diagram allows a holistic representation of the research methodology, including the connections between its components. It links the research questions with the process of conducting the study to arrive at the answers to these research questions, the expected outcomes and contributions to knowledge, as well as indicating the criteria for justification. It thus establishes the rationale of the research format and the research process. The methodological framework of this research is shown in Figure 3.2.

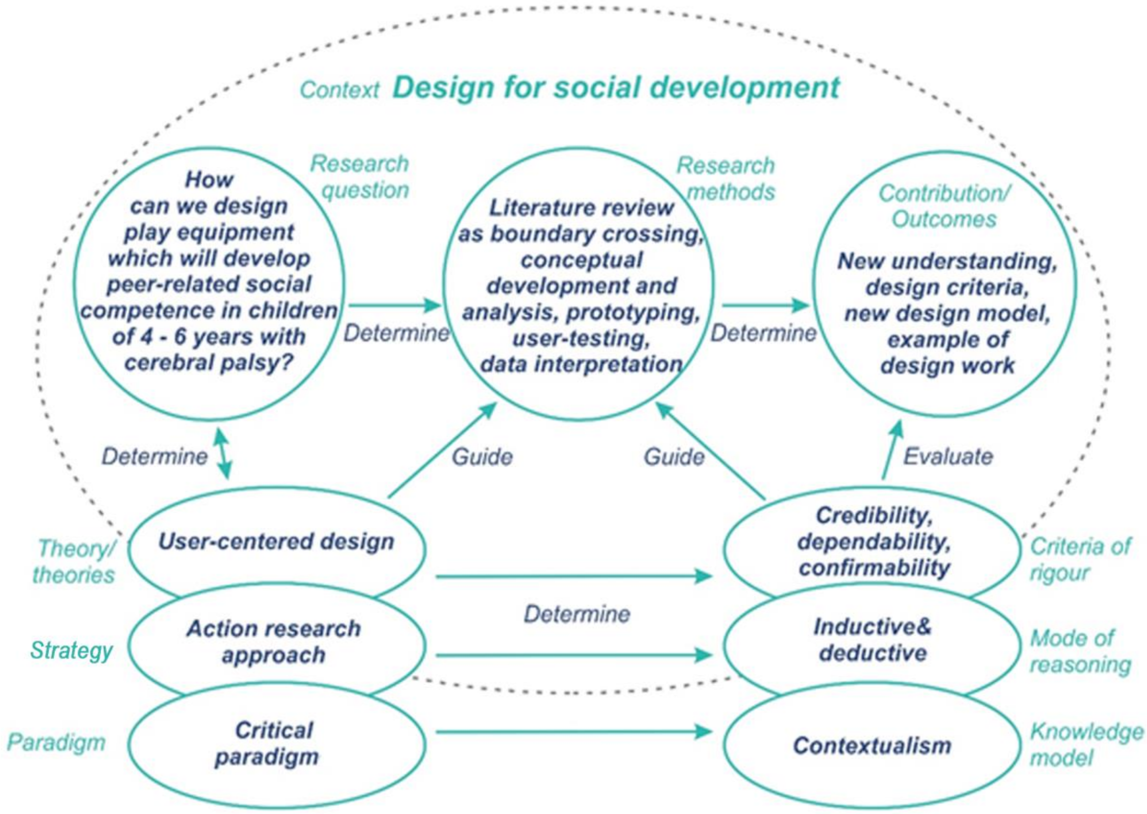


Figure 3.2. The methodological framework as applied to this study

The research question, "How can we design play equipment which will develop peer-related social competence in children of 4 - 6 years with cerebral palsy?", determined an interpretive conceptual model of the research, which in turn defined the form and context for answering the question. According to Fawcett (1999, p.9), conceptual models act as "*a guide for theory generation through application of its research rules".* They also determine the knowledge framework and the applied criteria of rigour (Niedderer, 2013) for evaluating the enquiry. The research methods are determined by the conceptual model and research question. The research question also determines the outcomes of the investigation. The next sections discuss the components of the diagram in more detail.

3.2.3 Research strategy: Action research

This study adopted an action-research approach, combining investigation with design practice, which included the design of play equipment for children with cerebral palsy. Cohen *et al.* (2000, p.227) state that the action-research approach is a flexible, context-dependant, reflective methodology that offers "rigour, authenticity and voice". Noakes (2010) considers action research as a form of self-reflective enquiry by the researcher, adopted in order to improve understanding of practices within a context and with a goal to increase social justice. Somekh (1995) says that it intends to address the issue of how research impacts on or improves practice.

Furthermore, action research is a cyclical problem-solving approach. The stages of action research, namely planning, action, observation and reflection, often repeat or overlap. In this study, these stages were applied iteratively to accommodate the design process which by its nature is iterative (Jorda *et al.*, 2015). Action research thus matches the designer's iterative and action-based work practice (Brandt, 2004), making it a suitable approach for developing and evaluating the effects of play equipment on the children's play and their interactions with each other.

The second reason for applying an action-research approach was that it is mostly used in small-scale studies that aim "*to produce both action (introduce a solution to a practical problem) and research (add to the body of knowledge of a particular field)"* (Warpas, 2013, p.72). The outcomes of action research are primarily focused on contributing to the knowledge and understanding of a particular field (Denscombe, 2010; Hayes, 2011; Warpas, 2013).

Zuber-Skerritt (1996) considers some practical issues that researchers who employ an action-research approach might face, such as the possibility that samples might be too small to produce meaningful data sets; difficulties in defining methods for coping with the amount of obtained data over a limited time scale; economic rationale. To counter these issues, purposive sampling was used to choose the participants for the study (section 3.3). The data collected through non-participant observations of the children and semi-structured interviews with parents and conductors ('conductor' is a special name for practitioners at NICE) were optimised and analysed through thematic analysis.

3.2.4 Children as participants in the research

As part of the holistic perspective, it is necessary to consider the specific challenges associated with research with children. Recent debates about child-friendly research have highlighted the differences between undertaking research with children and with adults (Punch, 2002; Fargas Malet, 2010). Previously, research was primarily *on* children, while in the last two decades the focus has shifted to research *with* or *for* children (Mayall, 2000). According to Punch (2002, p.322), there are three approaches for understanding children in the context of the research:

1. Children are practically the same as adults,
2. Children are completely different from adults,
3. Children are similar to adults but with different competencies (James *et al.*, 1998).

In the first approach, the research methods can be the same as for adults, as the researcher regards children as not distinct from adults. This is problematic because the understanding of the researcher as an adult tends to ignore the developmental characteristics of children. In the second approach, where children are identified as completely different from adults, the most popular ways to understand children's views are participant observation or ethnography. However, it can be argued that the adult researcher cannot be an equal participant in children's activities and cannot avoid affecting the children's world. The third approach where children are recognised as social actors with their own perspectives on their lives (James *et al.*, 1998) corresponded most with the focus of this study.

3.2.5 User-centred design approach

Perceiving children as actors with their own perspectives has led to increasing the use of participatory research methods and the adaptation of traditional methods (Fargas Malet *et al.*, 2010). Participatory design approaches (or co-design) consider users as partners in the design process and give them a significant and responsible role, where they can work collaboratively with the designers (Muller & Druin, 2002) in order to create a product for their needs or wishes.

Although it was important to understand children's perspectives for the purposes of this research, it was not feasible to give children an equal role to the designer, as they could not discuss educational goals in social development which they had not yet reached (Druin, 1999). Also, target children were from 4 to 6 years old with speaking and communication difficulties and their opinions regarding the design might not have been interpreted correctly. An important point was to collect necessary data with minimal intrusion into the children's daily routine in order to avoid possible behaviour changes because of new tasks or activities required.

Therefore, a user-centred design approach was applied within initial data collection, the design, and data collection during the design intervention. User-centred design put the intended users of a product at the centre of the design process from the information-gathering stage to the design development, prototype building and evaluation stages (Norman, 1988; Norman & Draper, 1986). This helped to understand whether a product corresponded to a user's needs or not and to what degree it did so.

It was vital to understand children's needs, their social skills and their preferences in toys, and to collect these data before the design development. To compensate for children not being able to actively participate in the research (for instance, through the interviews), a combination of different methods for eliciting different aspects from different stakeholders was chosen to build up the desired holistic picture. These methods were semi-structured interviews with parents at the start of the research (section 4.5); observations of children before and during the design intervention (section 4.4 and 6.2); discussion of the design ideas with parents and conductors to get their feedback on design concepts (section 4.6.3 and 4.6.4); and interview with conductors after the implementation (section 6.3) to get their feedback on the effectiveness of the prototypes.

3.2.6 Stages of the research

The action-research approach was used to develop a research plan for this study. This is presented in the form of a diagram (Figure 3.3) which visualises the main stages of the whole research process, and is followed by discussion of the aims and expected outcomes of each stage.

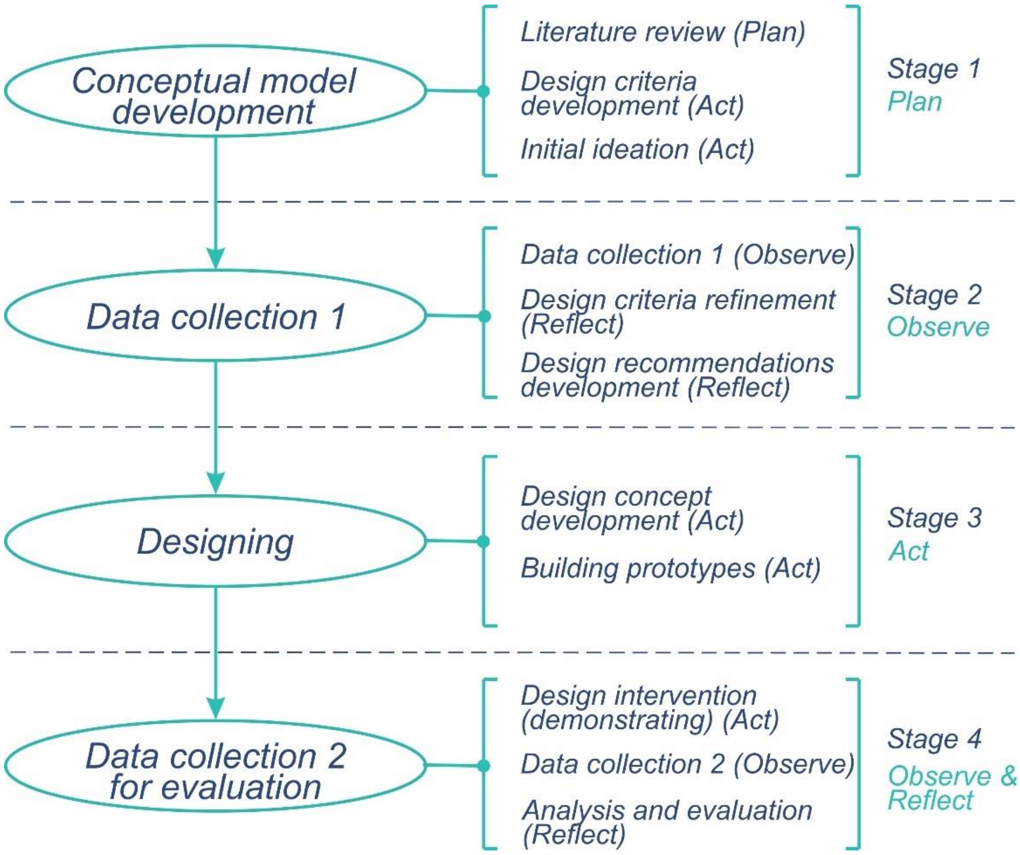


Figure 3.3. The research process

Stage 1: Planning – Conceptual model development

This stage collected and analysed relevant information on the current state of research into children's social development to understand the nature of gaining social skills for these children and the existing solutions which aid the issue of social competence.

This study explored how to facilitate the development of social competence in children with cerebral palsy through design by creating specialist play equipment for engaging them in relational play. The outcomes of the literature review were used as a basis for the development of the conceptual design model of and design criteria for creating play equipment, and, in parallel, the development of the first design ideas. A new design concept - play equipment for developing peer-related social competence - was created. This was based on the theory of object-centred sociality and regarded play equipment as a mediator in peer interactions between children (presented in section 2.4.1). This concept, together with information from the literature review, served as a basis for the design criteria development (presented in section 2.4.4).

Based on the above, a number of initial design ideas were developed through ideation and intuitive hand sketching. Hand sketching was used at this stage, not only as a tool for generating ideas through the sketching process, but also as a tool for visualisation and for presenting ideas to parents and conductors (Silav, 2013). Design ideas from this stage were used for further refinement and development after collecting data from the observations and interviews.

In this research, play equipment was considered as a means of triggering social interactions between the children. To judge the effectiveness of the suggested design model, it was important to define children's engagement with toys as a first step towards them practising social skills. The next step was to gather data about children's social interactions and communication.

Stage 2: Observing and interviewing – Data collection 1

This stage involved the observation of children and interviews with their parents. Observations and interviews were chosen in order to identify the level of development of social competence of the children before and after the design intervention in relation to their social skills as indicators of peer-related social competence for children aged 4 – 6 years.

Stage 2 started by finding an appropriate setting where observations of children could be conducted. The project was conducted in collaboration with the specialist educational provision, the National Institute of Conductive Education (NICE) in Birmingham. Research began with my first visit to NICE to observe the setting itself, to see the toys and equipment already available there, and to meet the conductors and two groups of children: a nursery group from 3 to 4 years and a primary-school group from 5 to 11 years. A pilot study was conducted prior to the main observation study (see section 4.3).

The main focus of this stage was to gather qualitative information about, and reflect on, the current level of social competence of children, as well as to define the key characteristics for the new play equipment, introduced for this research. The data were gathered through non-participant observations using recording sheets adopted and modified from Sylva *et al.* (1980) and through recorded interviews with parents. A rationale for using non-participant observations and semi-structured interviews as data-collection methods is discussed in section 3.6. Examples of the completed recording sheets and transcriptions of the interviews are presented in Appendices C and E.

Data were analysed in relation to the criteria for play equipment and to peer-related social skills (see chapter 4) by using qualitative analysis (Koshy, 2005; Braun & Clarke, 2006) (discussed in section 3.7). The data allowed understanding of the presence or lack of social skills in the children and of the extent of their engagement with existing toys and equipment. It also allowed the possible space for placing the prototypes to be identified. In response to the outcomes of this analysis, the design criteria were refined and design recommendations to complement these criteria were formulated.

Stage 3: Acting – Designing

At this stage, the conceptual model of play equipment for developing peer-related social competence in children with cerebral palsy was further developed. For this aim, systems analysis was employed (Andersson, 1990; Luthe *et al.*, 2013) (see section 3.8). From this concept, ideas of play equipment were created through task analysis and ideation through hand sketching.

Two additional meetings, one with parents and the other with conductors, were organised to discuss these ideas and to get their feedback. Ideas were developed further from their suggestions. Through this process, the idea for a thematic play environment, consisting of new toys for practising social skills, was developed, as it corresponded best to the conceptual model of play equipment and met most of the design criteria and recommendations from parents and conductors.

Due to the constraints of this study, for the final implementation two toys from the play environment were chosen for realisation as functional prototypes, so as to explore how they worked in practice. This allowed testing of the conceptual design model and support for theoretical insights gained from the empirical findings.

Once ready, the prototypes were delivered to and installed at NICE. Before they could be used by the children, these had to meet health and safety requirements. Risk analysis based on the Risk Assessment Criteria Form from the Product Safety Forum of Europe (PROSAFE) was used. This risk analysis allowed examination of use of the product, including the likelihood and seriousness of possible unsafe elements. Informed consent was obtained from parents during the first presentation, which allowed their children to play with the new play equipment.

Stage 4: Observing and interviewing – Design intervention and data collection 2

At this stage, the children participating in the study were observed while playing with the prototypes. In a focus-group discussion afterwards, five conductors were invited to give their feedback on this equipment and on the participation of the children in the play sessions. The main focus of this stage was to evaluate how children used the play equipment provided, their level of engagement with the toys and the level of interactions between children while playing with this equipment. In order to evaluate these aspects, two types of indicators were defined: indicators of engagement and indicators of peer-related social competence (see section 3.5). Data regarding social peer interactions were analysed (Mason, 2002). Insights from the observations demonstrated effectiveness of the design criteria and the conceptual design model.

3.3 Sampling

Exploratory sampling was utilised to choose the research participants. This is most appropriate for small-scale research with qualitative data (Denscombe, 2010). Exploratory sampling, in contrast to representative sampling, is for probing relatively new ideas, theories or topics and for generating insights. It was important for this research to explore how the children with cerebral palsy interacted with their peers, which social skills they had or did not have, the ways in which they demonstrated these skills and how they played with available toys.

The samples were chosen through a purposive technique of non-probability sampling, whereby participants were selected on the basis of known attributes and stated criteria (Hoeber *et al.*, 2017). Purposive sampling is particularly well suited for choosing an exploratory sample (Denscombe, 2010) and this approach was adopted to ensure that a wide-enough cross-section of children with cerebral palsy was included. Children with different manifestations of cerebral palsy (moderate and severe) and with different levels of development were chosen with the help of the conductors, based on their prior knowledge of working with such children.

Each participant had to fulfil the following criteria:

- Be diagnosed with cerebral palsy,
- Be in the age group from 4 to 6 years old,
- Attend NICE,
- Have a parent who agreed to participate in the research.

There were no exclusion criteria, but it was important to include children with varied implications of cerebral palsy. Additionally, the same sample participated before and during the design intervention and data-collection stage, at the same setting in similar conditions.

3.4 The role of experts: parents and conductors

An understanding of the design context, research design, health and safety processes, design development, design implementation and feedback afterwards was largely informed through the collaboration with conductors and parents, who were sharing their experiences and their understanding of the children's interests, motivations, needs, etc. The conductors and parents were chosen as key intermediaries and experts in this study on the basis of several principles, as suggested by Mikecz (2012) and Stewart (2001): experts should be selected according to the aim of the research; they should represent their field of competence; their professional activities should be directly or indirectly connected with the research problem; they should not be directly connected with a solution of the research problem in their professional activities; and they should be willing to share information and insights with the researcher. The experts were selected through convenience sampling.

The experts played a number of roles during the stages of this research and informed the research process as a whole. The conductors facilitated access to the children and talking with them in the exploratory phase of the research was an efficient and effective method of gathering data (Bogner *et al.,* 2009) about conductive education, the specific setting and the activities of the children and their development.

During the initial data collection prior to the design intervention, parents also became participants in the study and contributed to the data collection. Interviews with them provided insights into children's communication and preferences for play and toys. The conductors acted as advisors regarding the research design and data-collection methods. In addition, a number of informal conversations with the conductors were carried out to deepen understanding of the data from the observation of children. These provided information about the children's activities, the assisting facilities and the toys used in those activities, also about challenges which children with different manifestations of cerebral palsy could face during the activities, as well as developmental goals for children to achieve.

During the development of design ideas, the conductors and parents played the roles of advisers and co-designers. Selected design ideas were presented in hand-sketch form to and discussed with them regarding the potential of the ideas and suggestions for possible improvements. The sketches provided them with concrete visual information for critique in terms of their suitability for the children. With the researcher they went through possible play scenarios, defining challenges children might experience during play and potential solutions to these. This process deepened an understanding of the design task and gradually led to the final design of the toys. The conductors also provided information regarding health and safety requirements of the play equipment.

At the stage of evaluation of the design intervention, the conductors again became participants in the study. The group interview after the intervention allowed informed and independent review and evaluation of the children's responses to the design to be obtained. The employment of the conductors' (experts') evaluation was also intended to reduce possible bias of the researcher regarding the effectiveness of the play equipment (Marshall, 1999). Steps taken to minimise bias are discussed in more detail in section 3.10.

3.5 Indicators of engagement and indicators of social competence

In order to examine how play equipment designed for children with cerebral palsy facilitates the development of their peer-related social competence, two main aspects should be considered:

1. Children's engagement with the play equipment
2. Children's social skills which are necessary to be socially competent.

3.5.1 Indicators of engagement with the play equipment

Children's engagement with play equipment is a prerequisite for practising social skills through use of this play equipment. Therefore, it can be considered as a necessary condition for, and an observable indicator of social skills facilitated by, the designed play equipment.

In order to define the level and quality of children's engagement with the new play equipment with regard to their participation in relational play, it was necessary to determine indicators of engagement which could be observed during their play sessions. To determine these indicators, it was necessary to consider what engagement means in the context of this study.

McWilliam & Bailey (1992) identify engagement as the amount of time children spend interacting appropriately with the environment (social or physical). Krantz & Risley (1977) suggested identifying the number of children involved in activities and calculating the percentage of the total number of children present as an indicator of the extent of children's engagement. This approach was not suitable for the context of this study because all observed children participated in the play with the play equipment provided and they were involved in these activities during the whole play sessions, which lasted for 15 minutes for each toy.

Instead, approaches by Greenwood & Carta (1987) and McWilliam & Bailey (1995) are more appropriate, because they shift from identifying children's engagement through quantitative measures to examining its quality and type. According to Fredricks *et al*. (2004), engagement can be characterised as follows: behavioural, emotional and cognitive.

Behavioural engagement means involvement in activities. In this research, behavioural engagement was interpreted as children's involvement in play with the play equipment. Indicators of behavioural engagement in this context could be physical and non-physical contact of the children with these toys. Physical contact included, for instance, touching, pushing, pulling or squeezing the toy or parts of the toy. Non-physical contact with the toys included looking at the toy, pointing to it, vocalising or speaking to the toy and listening to the toy's melody.

Emotional engagement means positive reactions of children to activities. In this study, it was understood as positive reactions of the children towards the play equipment. Indicators of emotional engagement included, for instance, positive facial expressions, spontaneous smiling, physical movements to express emotions (except involuntary movements which were manifestations of cerebral palsy), curiosity, exploration of the toy, singing or vocalising with the toy.

Cognitive engagement means investment in the activities. In this research, this was interpreted as overcoming challenges and finding ways of playing with the play equipment. Indicators of cognitive engagement could include a child's understanding of how to play with the toys or finding her or his strategies of doing so.

Indicators of children's engagement with the toys are shown in Table 3.1. These indicators were investigated through non-participant observations of children and are discussed in section 6.3.

Table 3.1. Indicators of children's engagement with the toys

Indicators of engagement	
Behavioural engagement	Physical contact: - touching, - pushing, - pulling or - squeezing the toy or parts of the toy. Non-physical contact with the toys: – looking at the toy, – pointing to it, – vocalising or speaking to the toy, – listening to the toy's melody.
Emotional engagement	– positive facial expressions, – spontaneous smiling, – physical movements to express emotions (except involuntary movements which were manifestations of cerebral palsy), – exploration of the toy, – singing or vocalising with the toy.
Cognitive engagement	– understanding how to play with the toys, – finding own strategies of playing with the toy.

3.5.2 Indicators of peer-related social competence

Social competence of early-years children includes a number of social skills which children should have in order to effectively communicate with their peers (Katz & McClellan, 1997). The main social skills which children should develop to be socially competent were defined in section 2.3. These included:

- observing other children,
- making eye contact with other children,
- smiling to and with other children,
- listening to others,
- talking or gesturing to and with others,
- sharing,
- taking turns,

- cooperating,
- helping,
- initiating contact.

These social skills acted as indicators when exploring interactions of the children with their peers before the design intervention and during the play sessions with the designed play equipment. Indicators of social competence and indicators of engagement were examined through methods discussed in the previous sections.

3.6 Data-collection methods

The participating children experienced cerebral palsy at varied levels and were at different stages of development. This demanded some additional requirements, which had to be taken into account when choosing methods for a child-centred data-collection approach. Methods to understand the main users and to inform the design process included:

- Non-participant observations of children's play (discussed in section 4.4),
- Co-designing with parents and conductors through discussion of the design ideas (discussed in section 4.6.4),
- Interview sessions with parents and conductors (discussed in sections 4.5 and 6.3).

3.6.1 Observations of children

Observations in this research were a way of generating "multidimensional data on social interaction in specific contexts as it occurs" (Mason, 2002, p.86). They are seen to be particularly suitable where other methods could be rejected by children or where they might simply be inappropriate for certain ages (Lobe *et al.*, 2008; Mason, 2002). Semi-structured observations were chosen as most appropriate for recording data of predefined types but also because they were open to monitoring of all aspects which seemed relevant to the topic (Simpson & Tuson, 2003). The purpose of the observations was to obtain a view of the extent to which children interacted and engaged with each other within the play activities.

In preparation for the observations and to provide some background information before the actual data collection, pilot observations were conducted. A nursery group of children from 3 to 4 years and a primary school group from 5 to 11 years were observed in their course time. This allowed the recording sheets to be tried out and improved before conducting the main observation study.

The observation recording sheet that was developed was based on one provided by Sylva *et al*. (1980). It was divided into five sections: general information, timing, activity record, interaction record and social code. A new section for indicators of engagement was added to the sheet for use in observations 2. Two columns, 'social code' and 'indicators of engagement', were filled in just after the observation sessions to indicate the type of interactions observed, the children's engagement with the toys and the nature of their social competence if present. A template of the recording sheet which was used is in Appendix B.

In addition, field notes were gathered to remember and record (Burgess, 1991) the observed behaviours, activities and interactions between children in the setting. Field notes helped to produce meaning and understanding of the social situations between children. This aided the later design process.

In the non-participant observation the observer did not interact with the participants of the study. The observer was "an interpreter" (Mason, 2002, p.85) and only took notes without interrupting the children's activities. Even in non-participant observations there can be a risk of a Hawthorne effect (a change in the behaviour of the participants due to their awareness of being observed (Chiesa & Hobbs, 2008)), and, as a consequence, artificiality in children's behaviour. The chosen research setting here proved an advantage because the children viewed the observer in a similar way to how they observed a conductor or teacher and therefore were not surprised or frustrated (Robson, 2002). The observations took place in parallel with the interviews. Detailed information about the observations is in section 4.4.

3.6.2 Interviews

Semi-structured interviews with parents were conducted to obtain detailed data regarding children's interactions and communication, their play preferences and their ways of engaging with toys before the design intervention. A semi-structured group interview with conductors collected data about children's peer-to-peer interactions when using the specialist play equipment after the design intervention. Conducting interviews is recommended when

> *people's knowledge, views, understandings, interpretations, experiences, and interactions are meaningful properties of the social reality which your research questions are designed to explore (Mason, 2002, p.63).*

Interviewing is a flexible and adaptive way to obtain data (Robson, 2002). Interviews in this study provided an opportunity to capture and understand personal opinions through careful questioning and guided conversations. This allowed directly asking parents and conductors about certain issues and situations, such as the frequency and quality of social interactions of their children with peers, their favourite types of play and toys, desirable toys' characteristics and goals which parents and conductors wished their children to achieve.

The interviews with parents and the group interview with conductors were seen as appropriate for this small-scale study, where the researcher is the interviewer (Robson, 2002; Drever, 2003). Their semi-structured nature allowed them to be flexible but at the same time focused on the information which was being sought. A list of topics/questions was developed, but the sequence of asking about these, the amount of time allowed for answering them, and the attention to certain details were varied. The list of questions for parental interviews covered four categories: general questions about the child, play activities of the child, toys used in these play activities, and interactions of the child with other children and adults. Interview questions for the parents and conductors are presented in Appendix C.

3.7 Data-analysis methods

This section discusses the data-analysis methods used in this study. In qualitative research, data analysis is an integral process of data collection, namely the processes of examining, categorising and combining the evidence (Patton, 1990). The purpose of data analysis is to organise the information so that it is manageable, to see the relationships among entities that are conceptually meaningful, and finally to lead to the findings (Koshy, 2005). The challenge of this procedure is to make sense of a large amount of data by reducing the volume of information, identifying patterns and constructing a framework to convey the essence of what the data indicate (Patton, 1990).

The complete data set in this research included audio recordings of the interview sessions, transcriptions of these, and completed recording sheets from the observations. Transcription of the interview recordings by the researcher herself was an important consideration because it helped to create a rich understanding of the data through immersion. It also provided the opportunity to add important contextual information that was not captured by the recordings and to see both a holistic picture and further design opportunities.

Thematic analysis was chosen as "*a method for identifying, analysing and reporting patterns within data*" (Braun & Clarke, 2006, p.79). Thematic analysis is both an inductive and deductive form of analysis. It focuses on understanding individual opinions and experiences of the participants (inductive) and is led by the research on designing for the development of social competence (deductive). Thematic analysis is a more appropriate strategy when mindful of background theories, and also when one wishes to remain open towards the data to discover new ideas. It is a flexible approach, which provides rich and detailed, yet complex accounts of data (Braun & Clarke, 2006).

The first phase of thematic analysis in this research was familiarisation with the depth and breadth of the data (Braun & Clarke, 2006). It involved repeated reading of the data and searching for meanings and patterns. The second phase was generating initial codes – define what the data were about and exemplify the same theoretical or descriptive ideas (Gibbs, 2007). Through systematic searches for recurring codes in the data set, some codes were merged, redefined or added where necessary.

After all the data were initially coded, the themes for sorting and collating coded data extracts were developed (Braun & Clarke, 2006). These themes were generated deductively from the prior research and then were expanded and refined by inductively generated themes from the data. Tables (presented in Appendix D) were employed in order to strengthen consistency in interpretation. During this phase, the coded data extracts formed a coherent pattern.

Themes should be considered valid if they accurately reflect the meanings of the data sets (Braun & Clarke, 2006). Discrepancies in the initial coding were identified and corresponding changes were made. After determining what aspect each theme covered, the detailed analysis was written. It was important that participants' personal opinions, experiences and thoughts were presented in ethically appropriate ways.

3.8 Design methods

This section covers methodological aspects of the design development. The design concept development required a complex systems approach that interconnected various aspects of designing play equipment. This systems approach (Andersson, 1990; Luthe *et al.*, 2013), together with creative thinking, provided a platform for discovering multiple aspects and conditions necessary for solving the problem – designing play equipment for developing social competence. The systems-approach concept attempts to incorporate the design components with the social components into one holistic system. In the context of this research, this allowed a new perspective on finding the design solution to a social issue to be conveyed.

The triangular design model presented in section 2.4.1 (Figure 2.18) linked the components of the system, such as children with cerebral palsy, specialist play equipment, relational play, interactions of the children with the play equipment and peer interactions between children mediated by this play equipment, into one holistic system. The relation of these components led to definition of the design criteria necessary to sustain the whole system and to guide the design-development process.

The design development started from the exploration of how to encourage relational play through design, while the concept of relational play reformulated the functionality of the new play equipment. The main function of this play equipment was to encourage shared play activities of children to practise social skills (defined in section 2.3.1) through creating a level playing field which enabled children with cerebral palsy to participate effectively in these activities. Based on this, the first ideation through brainstorming of possible solutions took place. The process started with some quick hand sketches of a whole idea, which was then developed and refined through several iterations. Through this phase, hand sketching was used as a process of thinking and an exploratory technique in gaining an understanding of the product's visual image and functional qualities (Karaata, 2016; Silav, 2013; Stones, 2006). The focus was on generating conceptual ideas without detailed elaboration and quality analysis. It was important in this stage not to be judgemental, nor to stifle imagination. An example of the results from one of the ideation sessions is presented in Figure 3.4.

Figure 3.4. Example of the first ideations

The ideas from the first brainstorming sessions were analysed in order to define which corresponded most closely to the design criteria developed in section 2.4.4.

After the data collection 1, the findings regarding the play equipment arising from the interviews with parents, the informal discussions with conductors and the observations of children, were developed into the design recommendations (presented in section 4.6.4). These recommendations, together with the design criteria, became the basis for the next stage of ideation, which was more analytical. A range of techniques was used in the hand-sketching process, from pen drawings and markers' sketches to watercolour sketches. They were produced for the purpose of thinking about the design task and presenting ideas visually (Stones, 2006) and were used as a communication tool for discussions with parents and conductors. The sketches demonstrated creative thinking and the process of development toward the final design solution.

Previous and new ideas which fitted best with the conceptual design model, design criteria and design recommendations were selected, explored and developed further.

The final idea of creating a group of 'toy-friends', where each toy encourages practice of a particular social skill, was developed through detailed exploration of design criteria, such as play affordances, ergonomic parameters, sensory and emotion criteria and social skills. The final idea was considered under the lens of the holistic system where it performed the role of a mediating element between the other components of the conceptual design model (section 2.4.1).

3.9 Ethical considerations

This research involved young, vulnerable children, therefore consideration of a wide range of ethical issues was required. The proposal was submitted for ethical approval to the Faculty Research Committee and a Disclosure Check (DBS) was made in order to allow the researcher to conduct research with vulnerable children, their parents and conductors.

Prior to the study, informed consent was obtained from the Director of the National Institute of Conductive Education. A first visit to NICE was then arranged in order to meet the conductors and to observe the setting itself.

The study involved young children and the consenting process had to be applied to them also. Working with such vulnerable participants can be challenging in terms of ethics. Scott (2018) does not recommend involving participants in the research who cannot consent by signing the consent form. At the same time, such participants are often from underrepresented groups due to disability or other factors and including them can provide valuable information and contribution to the research and benefits for them (Scott, 2018).

In order to include the observation of children in this study, consent was obtained by *"gaining the consent of those responsible for them, such as a parent or guardian"* (BERA, 2018). Informed consent (BERA, 2018) was obtained from their parents through distribution of the information sheet, together with the consent form. A short questionnaire was also sent to all parents (presented in Appendix A).

The information sheet stated potential risks and benefits, also the right to refuse participation and to withdraw from the study at any time. If choosing to withdraw, parents and conductors were given the option as to whether data collected up to that point could continue to be used within the research, or whether they preferred all data to be removed. The parents were asked to fill in a questionnaire to provide basic information about their children, such as age and gender, what group their child attended at NICE and on which days, contact details and whether they were planning for their child to attend NICE in the next academic year (so that the same children could be observed both before and during the design intervention). All participation was entirely voluntary. Parents who were interested in participating were invited to return the consent forms and the questionnaires to the researcher.

In addition, informal consent was obtained from the children. This was done through a presentation by the researcher and explanation of the reasons for her presence, all in language appropriate to children (Rozsahegyi, 2014). In line with Rozsahegyi (2014), the absence of any negative reaction was interpreted as passive consent for the observation to take place.

Due to the ethical challenges which researcher-designers may encounter in working with vulnerable participants, it can be difficult for them to access such end users, and therefore this has often to done with intermediaries, such as parents, carers and practitioners. Scott (2018) suggested that the points of view of such intermediaries are valuable because they see a target participant and can offer a perspective that may be different from the point of view of the researcher. In order get insights into the children's needs from the position of intermediaries, the interviews with parents and conductors, discussion of the design ideas with parents and conductors and informal discussions with conductors were conducted.

To compensate for children not being able to participate, for instance in the interviews, because of difficulties with communication, the research involved the following:

- The observation of children before the design intervention,
- Using methods that require a high level of interaction with the users, such as the use of prototypes,
- The observation of children's interactions during the design intervention.

Confidentiality of all the information was maintained in line with GDPR (2016). Names of informants were not linked to the data obtained and children, parents and conductors were identified by means of an identification number only. All computerised data, including transcripts of the interviews and their analysis, were password protected and only the researcher had access to them. Aspects of the data were shared with the research supervisors. Presentation of the data in the main body of this thesis and in appendices is in a manner that protects the identity of participants.

3.10 Critical considerations for the research methodology

To assess the rigour of the qualitative study, Lincoln & Guba (1985) and Guba (1981) suggested four criteria: credibility, transferability, dependability and confirmability. These criteria reinterpret the traditional parameters of rigour for the purpose of qualitative research (Shenton, 2004; Niedderer, 2013).

One of the most important factors in establishing trustworthiness is **credibility**. This is about establishing that the results of the research are true and believable (Lincoln & Guba, 1986). The following steps were taken by the researcher to increase confidence that the aspects being studied were accurately recorded:

- An early familiarity with the participating setting was established before the first data collection in order to get a deeper understanding and establish trustful communication from both sides. This was achieved through the preliminary visit to NICE, including acquaintance with conductors and the educational process, and through the pilot study.
- Piloting and research methods which are well established in qualitative research (Yin, 2014) were used. Non-participant observations were conducted to collect data about children's play and peer interactions, as they were seen to be a more adequate method for gathering data about early-years children (Lobe et al., 2007; Mason, 2002). Careful questioning and guided conversations were carried out in the interviews with parents and conductors.
- Honesty in informants when providing data was encouraged (Shenton, 2004). The processes of gaining consent for data-collection discussed earlier, including the option to withdraw at any stage, helped to achieve this. Before

each interview the researcher indicated that there were no right or wrong answers to the interview questions. All the data were presented without identifiers of the participants.

- Debriefing sessions between the researcher and her supervisors were held. Through these discussions, the vision of the researcher was widened in the light of the opinions and perceptions of others. Such meetings allowed ideas and interpretations to be tested and helped the researcher's biases and preferences to be recognised.

The next criterion considered was **transferability**. This refers to the extent to which the study can be transferred to other contexts. Lincoln & Guba (1986) suggest that it is the responsibility of the researcher to provide sufficient contextual information to enable readers to transfer findings, and for the readers to determine to what extent they can transfer results of the study to other situations. Although the findings of this study were not intended to be transferred, they related in some ways to other contexts and could help to inform their approach, for instance in relation to design for disabled children.

Dependability relates to the idea that research results are consistent and could be repeated (Lincoln & Guba, 1986). To address this, a clear and detailed description of the research process has been provided, so that it can be used as a model for other researchers wishing to repeat the study (Shenton, 2004).

Confirmability questions to what degree the research findings and how these have been gathered have been supported by the data and could be confirmed by other researchers. Tobin & Begley (2004, p.392) suggested that confirmability is about *"establishing that data and interpretations of the findings are not figments of the inquirer's imagination but are clearly derived from the data"*.

The role of the researcher in this study was critical, as she collected, coded and analysed data from the observations and interviews herself to discover emerging concepts and ideas. In this process, the researcher can bring bias into the research process, which could impact the outcomes of the study. However, there was a benefit in this study in being the lone researcher and observer, as this allowed for immersion in the context and attunement to the data about the children's interactions, which may have helped to gain deeper and more detailed information and insights. The researcher in this case was an integral part of the research process and its outcomes, and disconnection from this was not possible or desirable.

According to Galdas (2017), the main concern is *"whether the researcher has been transparent and reflexive"*, which includes criticality and self-reflective awareness about the research context, methodological choices, etc. Bias is not a binary term and its interpretation is not limited to whether bias is present or not. Some degree of bias is always present in qualitative study and there is no need for the research to be fully objective and opinion-free. While avoiding bias is impossible, awareness and acknowledgement can help to reduce it. Different types of potential bias were identified for this research (partially based on the types of bias in Scott, 2018) and the ways of how they were minimised are now discussed.

Interpretation bias, for instance interpreting the playing scenarios of the children in a more positive or negative ways, was addressed through triangulation (Lincoln & Guba, 1986; Olsen, 2004), matching data from the observations with data from the interviews with parents. Data regarding children's behaviour during varied activities, their play and their social interactions were triangulated with the data about play and social interactions of these children provided by their parents. Triangulation via data sources was also addressed by comparing data from separate participants, among both parents and conductors. During the observations, the researcher also had informal discussions with the conductors which deepened an understanding of the data.

To minimise evaluation bias, which could have occurred when evaluating the effectiveness of the play equipment, the analysis was based on a robust framework, in accordance with the indicators of engagement and of social competence developed in section 3.5, on transparent data presentation and on employment in the evaluation process of the conductors as experts. Interviews with the experts allowed triangulation of the data from the observations, so as to ensure that the research findings were obtained from the participants' experience and to reduce the influence of the researcher bias on these results as far as possible. Data from the observations were compared with the data provided by the experts.

Possible bias of the researcher during the design development and when choosing the final idea was addressed through the presentation of the sketches of design ideas to the experts, both parents and conductors, and through the discussion of their views regarding the potential of the ideas, possible improvements, suitability for children, etc.

Response and error bias in the interviews were addressed through methodological triangulation and triangulation via data sources by comparing the data between parents (during data collection before the design intervention), and by comparing the data from between conductors (during data collection after the design intervention). Also, the interviews were piloted to test the prepared questions (discussed in more detail in section 4.3); during the interviews additional questions were asked where clarification was needed; and the researcher did not reveal her personal view on any given questions.

3.11 Conclusion

This chapter has provided an overview of, and the rationale for, the overall approach and the methods applied in this research. It has presented the ethical deliberations, data-collection and analysis methods, design methods and issues related to the evaluation of the design implementation. The design of the study, based on the action-research approach, through theoretical enquiry with the design intervention, allowed the research issue of developing the peer-related social competence of children with cerebral palsy by means of the play equipment to be explored. The developed methodology makes a contribution to child-friendly, interdisciplinary methodologies in the field of design for health and well-being. The next chapter presents the findings from the data collection before the design intervention.

4 EXPLORATION OF THE CHILDREN'S SOCIAL COMPETENCE AND THE ROLE OF TOYS BEFORE THE DESIGN INTERVENTION

4.1 Introduction

This chapter discusses data from the first stage of the data collection in order to understand how the children play with the toys and each other, how they interact with their peers and to gain a basis for further comparison with the data collected with the design intervention. Data were gathered through observations of the children (see section 3.6.1) and interviews with their parents (see section 3.6.2) to get an insight on current social competence in the children, their social skills and interactions before the design intervention. The data also gave an insight on children's preferable toys as well as the desired toys' properties from a view of parents and conductors. These were analysed using thematic analysis (see section 3.7) and outcomes of this analysis are presented here.

4.2 Conductive education environment

The practical part of this research, as mentioned earlier, was conducted at Red Boots primary school at NICE – a specialist educational provision whose approach is conductive education. Conductive education aims to provide learning experience that is conductive to enhance the development and learning of those with neurological conditions. This approach helps in learning ways to deal with real life situations and acquiring orthofunction. Orthofunctionality, as described by Hari (1997, p.159) is a *"dynamically developing and progressive process of adaptation which considers the changing biological and social requirements of the individual".*

The primary aim of conductive education is to stimulate the developmental process leading to social integration (Cottam & Sutton, 1986). Conductive education therefore aims to create conditions necessary for an individual to meet continually increasing biological and social requirements, such as motivation, interest and interactions (Schenker, 2008).

This approach places a great emphasis on achieving one's maximum potential and independence and tries to find a balance between the child and the environment. It focuses mostly on the adaptation concerning the child's constitution rather than the compensations to the existing environment.

Red Boots school is an independent school for children aged from 0 to 11 years. It has a specialist pedagogical approach to disabled children’s development and learning through its whole day programme for children. Red Boots has full-time and part-time (up to 3 days per week) provisionss according to individual children’s needs, so children may attend it alongside their local special or mainstream school. The focus of this school is on nurturing children to get greater independence in every aspect of everyday life, including learning school subjects. Children are led by conductors (specially trained educators) through the integrated structured programmes to learn how to play, explore and to be an active learner (NICE website). Each child in the group has individual goals and is supported through their own individual approach.

The majority of activities are carried out in one big room on the ground floor. This room can be divided into two separate spaces by the movable sliding walls. There is a lot of specialist and play equipment for a variety of activities. Toys are primarily kept on multiple shelves around the whole room and used in play activities as well as in the educational process. The room has a few tables with chairs and a lot of free space for the varied tasks and for moving around conveniently. This space is organized differently depending on the activity performed.

4.3 Piloting

This section presents a pilot study that was conducted after the first visit and before the main data collection to help develop the data collection instruments. It took place at the same setting as the main data collection with two groups of children, one from a nursery and one from a primary school.

Piloting observations and testing prepared recording sheets helped to identify potential problem areas and drawbacks in the research tools prior to implementation the main observation study (Mason, 2002). To this end the nursery group was observed for 1,5 hour and the primary school group for 4 hours. As a result of piloting, the recording sheet was simplified to make it more feasible for the researcher to capture all the activities of children. The researcher decided to assign social codes only after the observation sessions rather than during the observation itself, so as not be distracted from the children's activities. Piloting observations also helped to be focused on the target child rather than the whole group and catch more details.

The interviews were piloted to test prepared questions and check timing. The participants were a mother of a child with developmental delay and a father of a child with typical development. As a result of interview piloting, the questions were regrouped in blocks which correspond to particular topics and form a logical sequence.

The recording sheet for observations and the list of interview questions can be found in Appendix B and C.

4.4 Observations of children

This section presents the findings from the children's observations which were conducted to explore the following questions:

1) In what activities and how do the children participate during their daily schedule?
2) What play equipment do they use and how?
3) How engaging are the activities and the play equipment used in these activities to the children?
4) How do the children interact with adults and peers during these activities and in between?
5) Which social skills do they demonstrate?

Finding the answers to these questions helped to obtain information about the children in order to prepare for the next stage of this research – design development and intervention. It also helped to examine indicators of engagement and indicators of peer-related social competence demonstrated by the children, which will be compared with the data gathered during the design intervention.

4.4.1 Children

The sample for the observations consisted of five children whose parents gave consent to participate in the research. All children attended Red Boots School on a part-time basis. They have a form of cerebral palsy with motor difficulties which in many cases is accompanied by other difficulties, such as with learning, communication and perception, related to the motor manifestations. The sample is inclusive in terms of having children with moderate to severe manifestations of cerebral palsy. According to CHASA (Children's Hemiplegia and Stroke Association) and My Child (CerebralPalsy.org), moderate cerebral palsy means a child needs braces, adaptive technology and medications to accomplish daily activities; severe cerebral palsy means a child requires a wheelchair and has significant challenges in accomplishing daily activities. The inclusiveness of the sample was strengthened with the help of the conductors, who have been familiar with all the children and helped to include in the sample children with varied manifestations of cerebral palsy. Children with mild forms of cerebral palsy have not been included in the sample, as they often can use play equipment intended for children with typical development. An overview of the target children presented in Table 4.1.

Table 4.1. Overview of the target children

Child	Child A	Child B	Child C	Child D	Child E
Gender	F	F	F	M	F
Age	5	4	5	5	4
Mode of attendance	Part-time	Part-time	Part-time	Part-time	Part-time
Cerebral palsy	moderate	severe	moderate	severe	moderate

The target children include one boy and four girls, three of them are 5 years old and two – 4 years old. They are in different groups and attend NICE at different days from 9am to 4pm. Groups typically consist of 5-6 children. Although, the sample include both boy and girls, the study is not focused on gender differences.

4.4.2 Procedure

Observations were carried out following the piloting discussed in section 4.3 and took place from 10th to 30th of October 2017. Non-participant observations were conducted during the children's daily routine, which allowed observing children with minimal disturbance of their activities. Moreover, the children were already familiar with the observer and the observer with the daily routine, settings and conductors. An overview of the observations is presented in Table 4.2.

Table 4.2. Overview of observations

Child	Child A	Child B	Child C	Child D	Child E
No of sessions	1	1	3	2	2
Time (hours)	5	3	9	8	6.5
No of children present	5	4	5, 5, 5	5, 4	5, 5
No of conductors	4	3	3, 4, 4	4, 3	3, 4

Observations were recorded using recording sheets prepared in advance (see section 3.6.1). Observation sessions usually started at 9am or 11am and lasted until 2pm or 4pm. The number of the observations for each child is different because some of the children attend NICE three times a week, while others just once a week.

The school has established daily routine, thus, observed activities were mainly as follows: structured task series in lying, sitting and standing positions (called lying, sitting and standing programmes), walking and crawling, registering, self-help activities, lunch, speech and manipulation lesson, and play.

The data recorded during observations include notes of the number of children and adults present, the activities performed by target children in their daily routines, specialist and play equipment used in these activities, children's verbal and non-verbal responses to the tasks, interactions between children - adults and children – children and children's engagement and interest to perform tasks. Findings from the observations discussed in the next section.

4.4.3 Findings

In order to answer the questions stated in section 4.4, findings derived from the observations are presented in the following categories: examples of the activities target children participated in, examples of play or special equipment used during these activities, examples of engagement and interest, and examples of social interactions and demonstrated social skills. These categories were explored for each child and are shown below.

Child A

Summary from the observation presented in Table 4.3.

Gender: female
Age: 5
Date of observation: 30.10.2017
No. of children present: 5
No. of adults present: 3
Activities observed: lying, sitting and standing programmes, registering, walking and crawling, lunch, play and curriculum subject.

Table 4.3. Summary from the observation of Child A

Examples of activities	**Examples of play or special equipment used**	**Examples of engagement and interest**	**Examples of social interactions**
Structured lying and sitting programme along with recalling a story	Cards with pictures from the story, mats	Showed interest in physical activity and tried to follow instructions from conductors (C). Performed tasks with physical support from C. Showed initial interest in recalling the story, but soon lost an attention and concentration	Followed group and personal instructions for physical tasks, more concentrated in one-to-one instructions. Smiled when P verbally encouraged her to do physical activity
Registering who are present	Paper figures "Mimi" which symbolize each child 	Showed interest and concentration	Followed a sequence of personal activities, non-verbally replied on questions
Skittles one by one in a pair along with learning numbers	Skittles with numbers on them and a ball	Showed interest in the activity, but not always concentrated	Smiled to C, followed simple instructions. Took turns with a peer only after several encouragements from C. Did not interact with the peer if not instructed
Sitting activity – getting out and putting toys in a box, counting	Teddies and a box, communication book with cards, suction grab rails	Engaged with teddies for a while	Responded by smiling and looking at C. Sometimes looked at other children
Lunch	Two handled cup, plate, special spoon	Looked active and engaged	Vocalized to C, chose from several options
Standing programme	Specialized ladder, chair 	Followed the consequence of tasks	Listened to C instructions, engaged when got one-to-one help
Walking and crawling	Ladder	Encouraged by C	Looked at C, tried to walk with help of C

From the observation, child A was responsive and engaged in most activities. She was quite active and concentrated, especially when verbally encouraged by conductors. She followed the majority of instructions, in particular when she got personal physical help with the tasks. The activities were mainly focused on physical development, such as use of hands, fingers, sitting and standing exercises, walking. She handled objects with difficulty and used mainly one hand. These activities were often accompanied by learning numbers and counting. Her participation showed some confidence and engagement. Interactions were observed primarily between child and adult in the form of smiling, vocalising, looking at, following instructions from a conductor. However, there were a few group activities, like skittles, when a child had a chance to play with her peer. She interacted with a peer by passing a ball after a few encouragements from the adult. Sometimes she looked and observed other children.

Child B

Gender: female
Age: 4
Date of observation: 31.10.2017
No. of children present: 4 children
No. of adults present: 3
Activities observed: lying, sitting, standing and walking programmes, registering, math, free play, snack time.

Summary from the observation presented in Table 4.4.

During the observation, Child B showed different levels of engagement. At some activities she looked smiley, happy and active, while at others she was calm or lost her concentration and interest. She had complex tremors and involuntary movements and needed one-to-one support to perform the majority of the tasks. She could point, touch and push some play objects, but could not handle objects without constant physical support from adult. The child responded to the instructions and communicated with conductors by vocalizing and raising her hands.

She had an opportunity to communicate with other children during free play time, however, she did not show any interest and was occupied with herself.

Table 4.4. Summary from the observation of Child B

Examples of activities	**Examples of play or special equipment used**	**Examples of engagement and interest**	**Examples of social interactions**
Structured lying programme along with learning colours	Coloured cards, mats	Tried to follow instructions from C. Performed tasks with physical support from C	Responded to instructions by vocalizing, followed C by her eyes
Registering who are present, introducing a new toy	Paper figures "Mimi" which symbolize each child, Mermaid toy	Engaged and concentrated	Pressed button on the toy (with help) when asked by C. Followed instructions, vocalizes
Group activity, math lesson	Cups with numbers, ruler, communication tool	Engaged for a while, then lost interest, join the task again after encouragements	Followed instructions. Corrected her mistakes when asked. Responded by moving hands and vocalizing
After activity chat	suction grab rails 	Active and happy	Responded by raising her hand, smiled
Snack time	Two handled cup, plate	Looked active and engaged	Vocalized to C, expected one-to-one help
Sitting and standing programme	Specialized ladder, chair	Responsive, but not concentrated	Followed instructions with one-to-one help
Walking	Ladder	Encouraged by C verbally and manually	Responded to instructions and tried harder when encouraged
Free play	Different toys on a table to choose from	Engaged in own activity	Played with her shoelaces, did not interact with other children

Child C

Gender: female
Age: 5
Date of observation: 11.10.2017, 18.10.2017, 19.10.2017,
No. of children present: 5, 5, 5 children
No. of adults present: 3, 4, 4 adults
Activities observed: lying, sitting, standing and walking programmes, registering, learning gestures, speech lesson, free play, snack time.

Summary from the observation presented in Table 4.5.

Child C was observed for three days. During observed sessions she mainly seemed motivated and interested in the activities. Sometimes she lost her concentration but re-joined the tasks after encouragements or repetitions of personal instructions. She interacted with the conductors by smiling, vocalizing, using her hands and observing. She appeared to be calm but showed independence and persistence in physical tasks. She could handle most objects, but with some difficulty. In peer interactions (during free play) she was an observer mainly, however, when asked by the conductor she shared her toy with a peer.

Table 4.5. Summary from the observation of Child C

Examples of activities	**Examples of play or special equipment used**	**Examples of engagement and interest**	**Examples of social interactions**
Structured lying programme along with pretend play	Pictures with animals, mats	Concentrated and engaged, active, performed tasks with verbal and manual support from C	Followed instructions, responded to encouragements by smiling, was aware of children present, vocalised when asked
Registering who are present	Paper figures "Mimi" which symbolize each child	Showed interest and engagement, followed a consequence of tasks	Actively responded to questions from C by vocalizing and smiling, passed "Mimi" to the other child when asked by C
Group activity, learning gestures with a cartoon about harvest	Suction grab rails on a table	Engaged but often lost concentration, re-joined the activity after personal encouragements	Responded to C, followed instructions, showed gestures when asked
Smelling and tasting fruits	Fruits on plates	Responsive and smiley	Responded by pointing on a fruit she liked
Speech lesson	Tablet	Followed instructions but often lost concentration	Followed instructions, smiled to C, looked at other children, vocalizes
Sitting and standing programme	Specialized ladder, chair	Responsive and engaged	Followed instructions with minimal one-to-one manual help
Walking	Quad canes 	Encouraged by C verbally and manually	Responded to instructions and tried harder when encouraged
Free play	Tablet, plate and vegetables toys, book, rattle	Engaged in own activity, calm, smiley	Played with the tablet independently, gave the tablet to the other child when asked (sharing), chose new toy when suggested, parallel play, vocalized to attract C attention, observed a peer when she played with the rattle.

Child D

Gender: male
Age: 5
Date of observation: 10.10.2017, 17.10.2017
No. of children present: 5, 4 children
No. of adults present: 4, 3 adults
Activities observed: lying, sitting, standing and walking programmes, registering, pretend play, snack time, math lesson, speech lesson.

Summary from the observation presented in Table 4.6.

Table 4.6. Summary from the observation of Child D

Examples of activities	**Examples of play or special equipment used**	**Examples of engagement and interest**	**Examples of social interactions**
Structured lying programme along with learning left, right and cardinal directions	Map, mats, stick	Performed tasks with continuous personal support from C, listened carefully to C	Responded to instructions by smiling, followed C by his eyes, replied to questions by pointing
Registering who are present	Paper figures "Mimi" which symbolize each child	Engaged in the activity, Looked tired and sometimes lost concentration	Followed instructions, calculated "Mimi" and pointed on the card with number, did not want to vocalize
Group activity, math lesson	Pinocchio toy, ruler, cards with numbers	Responsive, but not concentrated. Encouraged by C verbally and manually	Followed instructions. Measured the length of Pinocchio nose and corrected mistake when asked (with help of C). Responded by moving hands and pointing
Snack time	Two handled cup, plate	Looked tired but followed instructions	Chose what to drink by pointing on a juice
Sitting and standing programme with a doll Molly	Specialized ladder, chair, doll Molly	Tried to follow instructions, needed personal support, looked at Molly doll	Performed activities with one-to-one help, reply to C by vocalizing
Pretend play	Cards with characters which children should show	Chose card with a hen but did not want to be in the centre to show the hen	Smiled to C, observed other children

During two days of the observations, Child D showed different levels of responses and interactions. At some activities he looked smiley and engaged, while at others he looked tired and bored. He had complex manifestations of cerebral palsy and needed one-to-one support to perform majority of the tasks, especially with physical activities. The child tried to respond to the instructions and followed the tasks. Conductors often suggested to him two options to choose from, so he could point to reply. Although he was aware of other children and observed peers during some activities, mainly he was occupied with the structured tasks which he performed with personal help from the conductors. He had an opportunity for free interactions with his peers during the activity with pretend play. However, he was an observer and did not want to be in the centre or initiate any contact.

Child E

Gender: female
Age: 4
Date of observation: 11.10.2017, 18.10.2017
No. of children present: 5, 5 children
No. of adults present: 3, 4 adults
Activities observed: lying, sitting, standing and walking programmes, registering, speech lesson, snack time.

Summary from the observation presented in Table 4.7.

During the observations, child E seemed active and independent in many activities. She followed instructions and participated in activities which were of interest to her. She often lost concentration and needed reminders or encouragements to re-join the task. The child communicated with the conductors verbally by responding to questions, instructions and encouragements. She was occupied primarily with the structured activities and had a little opportunity for free peer interactions. However, during two days of observations a few situations for peer communication were noted. For example, she and her peer had to pass a toy car to each other, but after instructions from the conductor to pass the car, she continued to play with it independently. Her communication with peers was in the form of observing, playing near or copying other children's actions.

Table 4.7. Summary from the observation of Child E

Examples of activities	**Examples of play or special equipment used**	**Examples of engagement and interest**	**Examples of social interactions**
Structured lying and sitting programme along with practising speech	Pictures with animals, mats	Showed interest in physical activity and tried to follow group and personal instructions. Repeated sounds and words	Smiled when C verbally encouraged her, gave a high-five to C
Watching a cartoon "Little Red Riding Hood"	Suction grab rails	Showed interest, then distracted from the cartoon and looked around	Replied verbally on questions, repeated after another child
Individual programme	Knitting toy	Engaged in the activity, not always concentrated and often distracted	Followed instructions after several encouragements from C. Played near other children but did not interact with peers. Remove her hand when another child touched her
Lunch	Plate	Looked active and engaged, looked around	Responded to questions from C
Standing programme	Specialized ladder, chair	Followed the consequence of tasks, sometimes lost concentration	Listened to personal and group instructions

The analysis of the observation results provided valuable insights into how each child participated in the activities and interacted with the conductors and peers. The activities were primarily structured group and individual tasks. During these activities conductors provided individual and group instructions, encouragements and physical support in accordance with children's needs. Some children appeared more active and independent, while others needed more help and ono-to-one assistance. Children mainly interacted with conductors in the form of smiling, vocalising, pointing and following instructions. Peer interactions happened under structured activities and were initiated rather by conductors than by children. Findings revealed peer interactions in the form of looking at and observing others, smiling and parallel play. One situation was observed when a child vocalised to attract attention of others which may be interpreted as interaction initiation. There were also situations when children did not respond to peer communication and were more concentrated on their own activities or tasks. Discussion of findings form the children's observations together with findings from the parental interviews presented in section 4.6.

4.5 Interviews with parents

This section presents findings from the parental interviews which were conducted in order to discover play activities of their children, children's favourite and desired toys, social interactions inside and outside their families and parents' expectations for their children. The findings were used to inform the design development stage.

4.5.1 Parents

A sample was defined after parents got an information leaflets about the research, filled in a short questionnaires and signed consent forms (all the documentation is in Appendix A). An overview of the sample is presented in Table 4.8.

Table 4.8. Sample overview

Child	Child A	Child B	Child C	Child D	Child E
Parent	Father	Mother	Mother	Mother	Mother
Child's gender	F	F	F	M	F
Child's age	5	4	5	5	4
Other children in a family (child's siblings)	Yes (twin sister)	Yes (younge r sister)	No	Yes (younger brother)	Yes (two older sisters)

Either mother or father was interviewed about their child, totally four mothers and one father. Four parents have other children in their families, so four of five target children have siblings.

4.5.2 Procedure

Interviews took place from 11th to 26th of October 2017 at NICE before or just after the children's sessions when parents brought them to or collected them from the school. Interviews were conducted in a conversational manner with timeframe of approximately 30 minutes for each.

All the data were voice recorded and then transcribed for analysis. The transcriptions were carefully read through and coded in order to reduce data by excluding information which is not relevant. Then themes were identified for the reduced data to sort and collate them. The interviews provided information from parental view and allowed to triangulate data obtained from observations.

4.5.3 Findings

This section provides findings from the five parental interviews which deepened the understanding about the children's communication with adults and peers, ways how parents motivate and encourage their children to participate in different activities, reasons for choosing particular toys, parental perspective on toys and important properties which they pay attention to, children's favourite toys and short-term and long-term expectations of parents for their children. The interview findings are presented in four parts: social interactions, play equipment, motivations and expectations.

4.5.3.1 Social interactions

Two separate categories were explored for children's interactions within a family and outside the family. Interactions within the family were divided into interactions with siblings, parents and other relatives (children and adults). Interactions outside the family were divided into interactions with familiar children (friends, schoolmates, etc.) and adults (teachers, conductors, etc.) and strangers (children and adults).

From parental views, interactions within the family appeared more successful than outside the family. Moreover, communication with parents and siblings are even more effective in comparison to other relatives. One parent said:

> *"Her sisters are like her world. She wants to try everything that her sisters have. She plays pretend shop with her sisters. Her level of communication is very different between her sisters and her friends, for example".*

Another parent stated:

> *"She enjoys playing shared games with me and her dad, rather than playing on her own" or "when I'm busy cooking in the kitchen and her sister is also busy, but she wants to play and needs help, she just says – Mum, can you help me playing?".*

Interviews revealed that children enjoy playing with others and interact effectively in a supportive social environment, when people with whom they interact understand them and their way of communication "without words". A supporting example is, for instance, that the same mum who told *"when … she wants to play and needs help, she just says – Mum, can you help me playing?"* later said *"now she just started trying to use gestures to express what she wants to do",* which means that the child is non-verbal. It shows that a child has her own non-verbal way of communication and expression of her wishes and the parent perceive it as verbal "*Mum, can you help me playing?*".

The situation is different when it comes to communication with people who are not family members. Odom (2005) suggested that for some children with cerebral palsy acquiring the skills and knowledge necessary for interacting positively and successfully with peers is a challenge. Here opinions varied reaching from a child's confusion about interacting with others to openness and interest. For instance:

> *"She feels confused when a child suddenly just starts staring at her"* or *"You couldn't look at her or talk to her. She is not really social".*

While the other parents stated:

> "*She tries smiling to start interactions with them (children), she is fine when they are talking to her"*.
>
> *"She is quite happy to be among other children. She learns from them".*
>
> *"She sometimes may not initiate play with others, but she might want them to come to her".*
>
> *"He is observer, yes, he is sitting and observing other children".*

The interviews showed that most of the observed children have an intrinsic desire to be socially included. According to the parents, children use their own individual ways to indicate this desire, perhaps as the result of the motivating influence of play. A challenge may be in finding ways or strategies how to interact with others effectively:

> *"He wants to meet new friends. Before he was really scared of other children because he can't actually move his hands to show "stop" or "don't come", but now he is better – he has his communication book".*

In fact, a reason for difficulties in communication may be in an unsupportive physical environment (Hughes 2010, p.209), as in the case with a child's communication book. The communication book is a book which usually contains a variety of pictures or symbols organised into different categories. The child can choose and point to the appropriate pictures to communicate. Given an appropriate physical environment or tools, many challenges can be overcome (Hohmann and Weikart, 1995).

Also, some parents noted that there are more interactions with adults at school, rather than interactions with other children. For example, one of the parents said:

> *"there are more interactions with adults at school, rather than interactions with children, with [their] peer group".*

This may be because programmes at special educational provisions are more individualised and focused on individual achievements.

4.5.3.2 Play equipment

The findings from this category covered three main questions:

1) What toys children already have and which of them are favourite?
2) What problems do these toys have or what is missing?
3) Desired toys (even imaginary and non-existent), desired or important toys' characteristics, properties, etc.?

All parents reported they have a lot of varied toys at home for their children. Here is a list of toys which parents mentioned their children already have:

- Dolls, including Barbies and Disneyland heroes,
- Pretend shop,
- Toy musical instruments, such as trumpet and piano,
- Soft toys, such as teddy bears, Peppa Pig, etc.
- Blocks,
- Jigsaw puzzles,
- Play kitchen,
- Drums,
- Scooter, etc.

This list illustrates that the children have toys which are largely designed for children with typical development. Parents mentioned that there are not so many toys available in the market which would be physically suitable for their children. Also, the toys which are positioned as for disabled children are usually very expensive.

The favourite children's toys are:

- Disneyland heroes,
- Teddy bears,
- Peppa Pig,
- Piano,
- I-pod and
- Computer.

All five parents mentioned that their children like I-pods and computers, mainly because of video games and cartoons and because of the reasonably easy use of it. At the same time parents understand the possible negative effect of continuous use of these devices and try to limit play time with these. When children spend their time in the activities on computers and gadgets, they often do not pay attention to their posture and to the distance from their eyes to a screen, which affect their health (Alghamdi, 2016; Dorman, 1997). Computers and gadgets may have an isolating effect on children if they spent a lot of time with the computer instead of playing with peers and participating in varied social activities (Sundus, 2018; Alghamdi, 2016).

The presence of Disneyland heroes and Peppa Pig toys among the favourites may be due to their popularity in media and advertisement.

Consistently all the parents noted that their children cannot play **independently** with the majority of toys and always need an assistance, primarily because of inappropriate physical properties of the toys:

> *"We have a massive selection of toys, but majority of them she can't use to play herself physically. She needs help from adults".*
>
> *"It is really hard to find toys for her which are appropriate physically".*
>
> *"Many toys make her frustrated when she can't give a go and she keeps struggling".*

When children have weak arms, uncontrolled movements, muscle spasms and/or tremors, it is hard for them to hold and manipulate toys if there are no assisting elements, such as wrist strap, suckers, etc.

Parents were asked about significant properties they are looking for in toys. It was also suggested to try to describe an ideal toy real or imaginary, or separate characteristics which this toy should have. Sometimes it was hard for parents to define particular characteristics and they gave more general descriptions, such as

> *"Something she can interact with, but not get frustrated"* or *"Something which is easy to reach".*

Overall parents gave a lot of valuable details which helped to refine the design criteria developed in section 2.4.4 and formed a basis for the design recommendations (see section 4.6.4). Four of five parents expressed their desires to have toys which may allow independent play without assistance from adults. They expressed it, for instance, as follows:

> *"Anything that can make her feels independent".*

"Just anything that she can access and can do by herself. Physically appropriate".

"Something he can manage himself and not get frustrated".

These data supported the importance for children to be enabled to be **independent** and have opportunities to play with toys without continuous support from adults. Feeling independence in playing with the toys may foster self-confidence and increase motivation. In order to provide independent play with the toys, one of the main criteria is appropriateness to developmental level of the children. This supports the design criteria developed earlier (see figure 2.21 in section 2.4.4).

All parents described physical properties which could make toys more accessible and appropriate physically for children, for instance:

"Anything that would stand and doesn't move, or something that I don't need constantly to hold".

"Even easier art and craft things – paint brushes which maybe have a wrist strap. Pencils and glue sticks which are easy to hold".

"Something which is larger, for example play tea cups set".

"Colourful, developmental, easy holding".

"Bigger toys, not too many pieces".

"Not always plastic, maybe wooden. Nice and bright, colourful, also textured".

"Toy that shows video(s) which says to push something or press on. Interactive toy that guides".

These views formed a basis for developing the design recommendations (discussed in section 4.6.4) and informed the design development.

One parent mentioned that it would be good to have toys which reflect more diversity, for example dolls or soft bears, books which are focused on emotions and diversity. She also shared a concern that now children spend a lot of time using laptops, tablets or computers that may have a negative impact on them. Therefore, their family try to minimise the time their child spends with gadgets and read more books, play with *"toys for kids"* and not with gadgets.

These findings supported the fact discovered in the literature review that in a number of existent toys presented in the market today there is still a need in toys specifically designed for children with cerebral palsy. Available toys positioned as toys for disabled children are often intended for any child and in many cases physically inappropriate for children with cerebral palsy. It can be a challenge even to find toys which are stable, do not have small parts and do not require constant holding.

4.5.3.3 Motivations

Findings from the interviews gave an insight about children's intrinsic and extrinsic motivations to play, their interest to participate in varied activities and levels of concentration on particular tasks.

Two types of children's motivation were explored - intrinsic motivation to play that arises from within of the child and extrinsic motivation that arises from outside of the child. The intrinsic motivation involves participating in activities because it is personally rewarding, while the extrinsic motivation usually appears with extrinsic reinforcement, when children engage in activities to get rewards or to avoid unpleasant situations (Ryan & Deci, 2000).

From the interviews it became evident that although children have the intrinsic motivation to play, yet they need help to achieve this desire.

> *"She shows interest in everything and doesn't need encouragement to play" or "He wants to do everything. Even if he knows he can't, he wants to".*

It is often important to **encourage** them to participate in activities and parents found different ways how to **motivate** their children, for instance:

> *"I told him that he is a soldier and he needs to be like a big brother, he needs to show his little brother…"*
>
> *"I did it myself first, then she wants to have a go"*
>
> *"I reward her for doing it at the end"*
>
> *"Her sisters are very encouraging. They can persuade her to play with anything, no problem at all".*

Obviously, when children are interested in the activity and are able to do it, they are more engaged and show a higher level of concentration. The data also support this:

> *"She has quite good concentration when she is enjoying something"*
>
> *"Sometimes she has a focus and enjoys doing it but if she can't do something she becomes easily annoyed and doesn't want to do it"*

These data suggest that the activities and tools for these activities should be developmentally appropriate for children and focused on their strengths rather than weaknesses to trigger their desire to participate and overcome challenges.

4.5.3.4 Expectations

The interviews also offered a better understanding of parents' expectations for their children for short-term and long-term goals. All interviewed parents expressed their desires to see their children become independent. However, they are aware of the impact of cerebral palsy and often added phrases like *"independent as much as he can"* or *"as much as possible".*

As the short-term goals, parents want their children to develop independent toileting, sitting, using hands more, learning math and other school subjects, etc.

As a long-term goal, parents expressed understanding in importance of social competence of their children and social inclusion:

> *"I just want for her to be happy, to be inclusive to society, not exclusive".*
>
> *"I would like her to develop communication".*
>
> *"I think she has a lot of things which are going on in her head, so I just want for her to express those. I wish she will develop over time skills to express more what she is thinking about. I wish her to develop communication skills".*

Although at some points parents described their children as socially active and able to communicate effectively, when it comes to their goals for the children, the data showed their concern regarding social inclusion of their children.

It was explored in section 2.2.3 that social interactions and communication are vital for children's holistic development and are a prerequisite for building relations and friendships in future. Data from the parental interviews revealed that although some of them currently are more focused on short-term goals, such as preparing children for mainstream school or learning school subjects, for long-term goals they associate happiness of their children in particular with being independent and socially included, being socially competent.

4.6 Discussion

Findings from the nine observations of the five target children together with the five parental interviews provided detailed information about social interactions of each child with peers and adults, and the role of physical environment and the toys particularly in these interactions. Data analysis confirmed the key issues from the theoretical framework (see chapter 2) discussed below and formed the foundation for design development and intervention. It also served for refinement of the design criteria (see section 2.4.4).

4.6.1 Children's social interactions

Findings provided insights on the nature of children's social interactions in varied contexts, such as at the school during activities and free play sessions, and outside the school both with adults and peers.

Social interactions of children with parents and siblings, are rather successful, as family members usually understand children's wishes, intentions, expressions without efforts and have their own ways and strategies of communication. Similar situations happen in communication with the conductors who spend a lot of time with children. This corresponds with Winnicott's idea of "holding environment" which can be described as supportive transitional space for a child to his/her autonomy (1953, p.94).

However, parents recognised the importance for children to develop their social competence more broadly and expressed their concerns about social development of their children and their further inclusion into society. Guralnick (2001) proposes that the development of peer-related social competence should be a primary goal of early intervention and early childhood programmes.

This research is about peer-related interactions, so they are in the focus. Peer-related interactions at the school mainly could happen during group activities and usually were led and encouraged by conductors through verbal group and personal instructions, and personal help. Within the group work every activity is highly differentiated to accommodate individual needs. To perform such activities, the child usually got individual support from a conductor who offered encouragement, explanations, praise for progress or one-to-one manual help. Therefore, child – adult communication prevailed.

Odom (2005) observed that interacting positively and successfully with peers for children with cerebral palsy may be a challenge. There could be different reasons for this, such as physical presentations of cerebral palsy, different levels of ability for social interaction, and prevalence of 'vertical' interactions rather than 'horizontal' in everyday life. Non-verbal peer interactions in the form of looking at other children, smiling and observing other children were observed during free play times when conductors minimised their guidance and provided encouragement and support for children, so they could participate in a group play. However, even during these sessions children often were more concentrated on their own tasks, interests or toys.

4.6.2 Play equipment in peer-related social interactions

The school has a wide range of toys and special equipment, which were used purposefully in varied activities. The toys have different forms, colours, textures, weights and sizes from tiny for fine motor skills to toys proportional to child's body size. Some objects were adapted for children, like pencils with handles for easy holding, and some were initially specially designed for children with cerebral palsy, like crockery and cutlery. Several authors (Strain *et al.* 1986, Hughes 2010) highlighted that physical environment holds significant determinants of social communication.

In the context of social communication, the toys were used to attract and maintain interest and concentration, to perform certain tasks, but not as a means to initiate social interaction. Interactions were mainly led by adults whose pedagogical skills played a vital role. This confirmed the findings from the literature review discussed in section 2.4.5, that despite the vast number of toys, only few of them hold social function and were designed specifically for disabled children. It was observed that the conductors' innovation made it possible to use these toys meaningfully according to the group's and individual children's needs.

For example, the activities with toys where children practiced social skill turn taking were observed twice, when two children had to pass a toy car to each other and when two children had to throw a ball into skittles one by one. In the first case after initial group instruction from the conductor, a child who had the car continued to play with it independently. When she got a reminder to push the car to the other child, she looked at the conductor, but continued to play. After the encouragement and manual help, the car was pushed to the second child, who started playing with it. The situation repeated with both children a few more times. In the second case with skittles, children also took turns after a few encouragements. Practising turn taking social skill happened mainly following help from the conductors and was more a structured activity than initiated by children. This corresponds well with the view by Vygotsky's idea of Zone of proximal development (1978) and Fani & Ghaemi (2011) who said that the number of skills, which can be developed with social guidelines, are often wider than without.

The toys in both cases, although they played central roles in the activities, appeared not to hold social function in themselves. They were perceived as social objects around which interactions happened (Engeström, 2005) only under adult's guidelines. In contrast, the aim of this research is to design play equipment with intrinsic social functions, which engages children in relational play with only initial or minimal instructions from adults.

4.6.3 Refinement of the design criteria

Findings from the children's observations and parental interviews allowed to refine the design criteria developed in section 2.4.4. Figure 4.1 presents the initial design criteria.

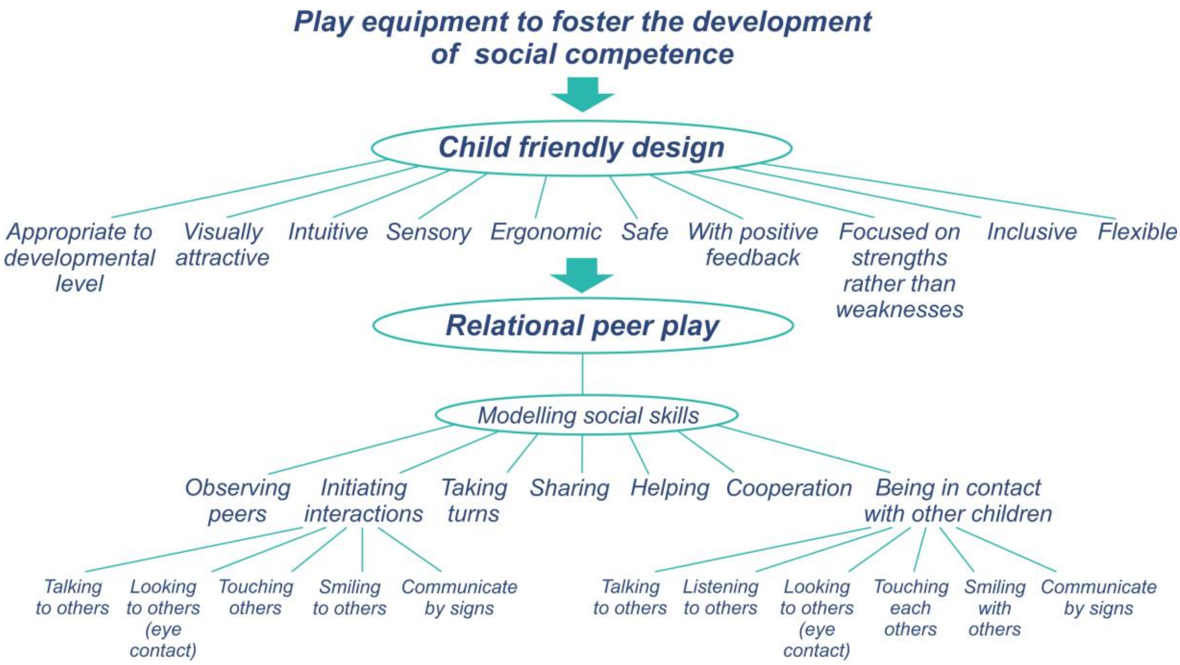


Figure 4.1. Design criteria

The refinement consisted of adding "fostering self-confidence" at the second level of the design criteria which pertain to the social purpose (see Figure 4.2). Self-confidence is a feeling or a belief in one's abilities and success (Perry, 2011; Mann *et al.*, 2004). Some parents noted that in some situations their children feel confused or insecure in interactions with other children. Children with high self-confidence perform better at varied activities, feel happier, experience fewer social difficulties and have better social communication (Mann *et al.*, 2004). Self-confidence is related with motivation, independence, courage and curiosity.

Curiosity drives children to explore and try new things (Loewenstein, 1994). It can be useful to keep children alert and give them desire and energy necessary to participate in the new for them activities and situations. Curiosity often promotes self-confidence (Dubey & Griffiths, 2017).

Self-confidence is positively correlating with intrinsic motivation (Benabou & Tirole, 2002; Sari et al., 2015). Findings from the interviews showed that the children mainly have intrinsic motivation to participate in the activities and to play, however they often need help to do so. Also, sometimes they may need extrinsic motivations and parents try to find different ways how to motivate their children to perform varied activities.

Self-confidence is often associated with courage, while courage can be seen as a prerequisite for confidence (Yeung, 2015). To get confidence children need courage to try something or to participate in the activities for the first time. Courage may help to overcome fear and insecurity.

Feeling independence for children in playing and performing the activities may foster their self-confidence and increase motivation. All parents supported the importance for their children to be independent and to be able to play without continuous support from adults. They also noted independence as a goal for their children.

The refined design criteria are presented in Figure 4.2.

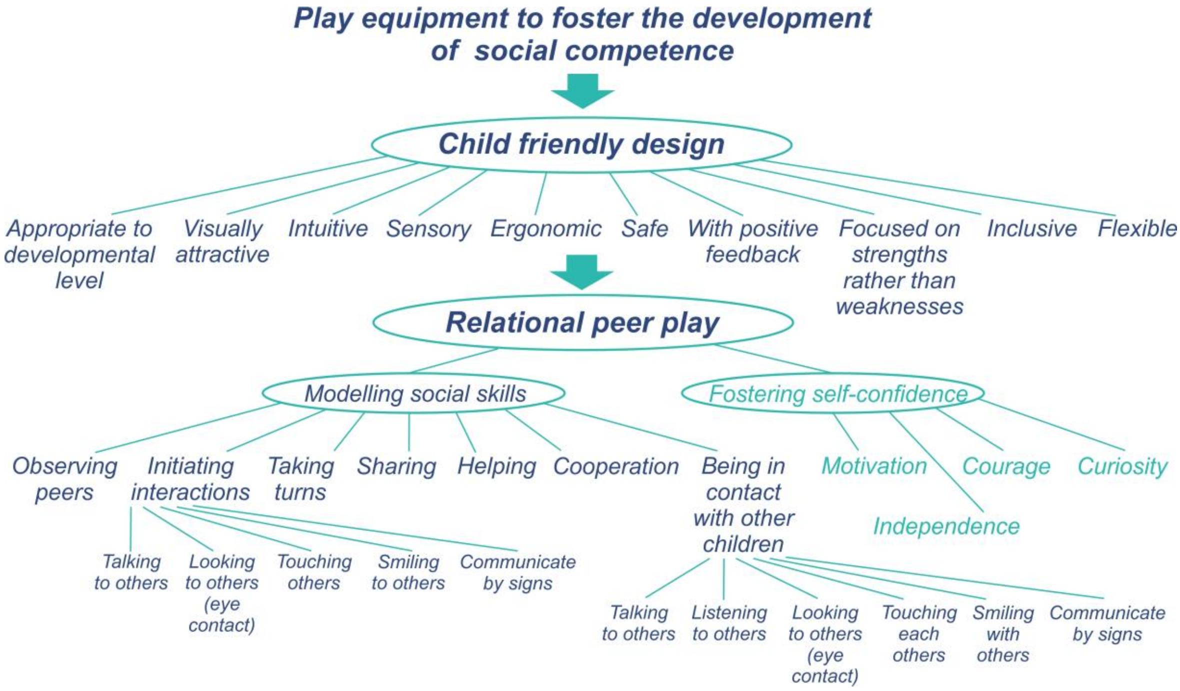


Figure 4.2. Refined design criteria

4.6.4 Design recommendations

Findings from the data analysis led to the formulation of design recommendations for creating specialist play equipment for the development of social competence. These recommendations complemented the design criteria and were taken into account in the design development. Recommendations were mainly distinguished from the analysis of parental interviews and presented below. Play equipment for children with cerebral palsy should be:

1) **Stable**. From the observations, it has become clear that children may have involuntary movements, weak arms, poor muscle control, muscle spasms and tremors, which make it difficult to hold toys. At NICE some special equipment have suckers, as for example suction grab rails or they put rubber mats under some toys to reduce slipping. Parents explained that they usually need to hold toys, so that children are able to play with them and not to be frustrated or disappointed when toys slip from their hands:

> *"She really likes her teddy bears. They are her favourites. She feeds them and says good night to them when we go into bed, and she gets so upset when she wants to hold that bear and can't".*

Stability of the toys allows children to play independently without continuous help from adults.

2) **Without too many small pieces**. Three of five parents mentioned that it is frustrating for their children when toys consist of small pieces and it would be better to have bigger toys. Observations showed that the school has a variety of small toys and toys which consist of small parts. Those are used under supervision in varied activities, for instance in order to develop fine motor skills. Although playing with small elements can be beneficial in developing motor skills, in play equipment for social interactions it can divert children's attention from communication because of the potential challenges in use.

3) **Without sudden effects**. Children may not notice too short effects, for example quick splash of light, due to their level of dexterity and reaction time. Interview data showed that it is better to have, for example, smoothly fading light or duration of illumination should be at least a few seconds.

4) **Washable**. From the position of health & safety, toys should be made of washable materials.

5) **Easy holding**. Data revealed it is important for toys to be easy holding, for example, with special wrist strap or texture. Week arms, lack of muscle coordination, muscle spasms, tremors, involuntary movements and clumsy movements are common representations of cerebral palsy. Therefore, it may be a challenge for children if toys require constant holding to play with. Texture may help to minimise slipping a toy out of hands, while wrist strap may help children to return the toy back to hands independently without adult's help.

6) **Encourage voice use**. Children may have delays in speech development or difficulty speaking which was observed in target children. The interviews revealed that parents prefer toys which help in practising sounds and speech.

Application of the design criteria and design recommendations during the design development and their implementation in the final idea of play equipment are discussed and presented in the next chapter.

4.7 Conclusion

Findings from the first data collection confirmed the importance of social competence for young children with cerebral palsy. Data analysis from the children's observations and parental interviews allowed to understand better the nature of the children's interactions with adults and their peers, and the role of play equipment in these interactions. Findings confirmed the design criteria developed earlier and allowed to refine and supplement them. Data from the interviews provided an insight on the physical properties which toys should have to be suitable for the children, which helped to define additional design recommendations to support and complement the design criteria. Findings from this chapter constitutes as a starting point for the design development and intervention.

5 DESIGNING FOR THE DEVELOPMENT OF SOCIAL COMPETENCE

5.1 Introduction

This chapter discusses the design development. It starts by refining the conceptual design model that sees play equipment as a mediator for building social interactions between children within their peer group. The play equipment is considered in the context of relational play. The discussion then moves to the ideation phase to show the journey from creating the initial design idea to the final design decision.

This final design idea is explored through the lenses of the following theories: play affordances; ergonomics theory; emotional theories; inter-sensory approach; and health and safety issues. A play environment, with the name "Undersea Friends", consisting of the toys intended for practising particular social skills, was created. It was based on the design criteria from the literature review, design recommendations formed after the data analysis, and the conceptual design model also developed through the literature review, with further refinements as the designs took shape. The chapter also presents the main steps in the building of prototypes and the challenges encountered during this process.

5.2 The conceptual design model of play equipment for the development of social competence

Play equipment in this study is treated as a part of the physical and social environment, and as a tool for engaging children in social peer interactions through relational play. It should provide a central point for interpersonal interactions between children, as discussed in section 2.4.1 of the literature review, and it should trigger these interactions, not only around itself but by means of itself.

The peer group can be seen here as a system of interacting participants who perform certain actions and participate in group relational play, where the relational play is a catalyst for the emergence of social interactions. The peer group can be defined as a number of individuals who interact with each other, are of similar age, and share several characteristics, such as difficulties with their independence, movement or communication. In view of this, consideration of the group can be scaled to the study of personality (Popov & Chompalov, 2014). However, the group is also heterogeneous, because of the complex and diverse nature of the children involved. Thus, the peer group should be considered as a socio-psychological entity with its own characteristics. From this arises the requirement that the play equipment should provide different levels of heuristic opportunities for children while playing with it. The requirements of the individual child become one component of the system within which the play equipment should efficiently encourage social interactions.

Therefore, the purpose of this specialist play equipment was to create necessary conditions for triggering social skills, including cooperation, taking turns, helping, sharing, initiating and being in contact with other children (see section 2.3.1), and thus for verbal and non-verbal social interactions during relational play. Social interactions can be considered in the context of simultaneous activities, common activities or common use, as well as the visual appropriateness of the play equipment, which encourages the emergence of this range of social interactions.

5.3 A journey to "Undersea Friends"

This section provides an overview of the design process of the toys which were designed to support children's development of different social skills. The diagram below shows how the research informed the design development, including a timeline.

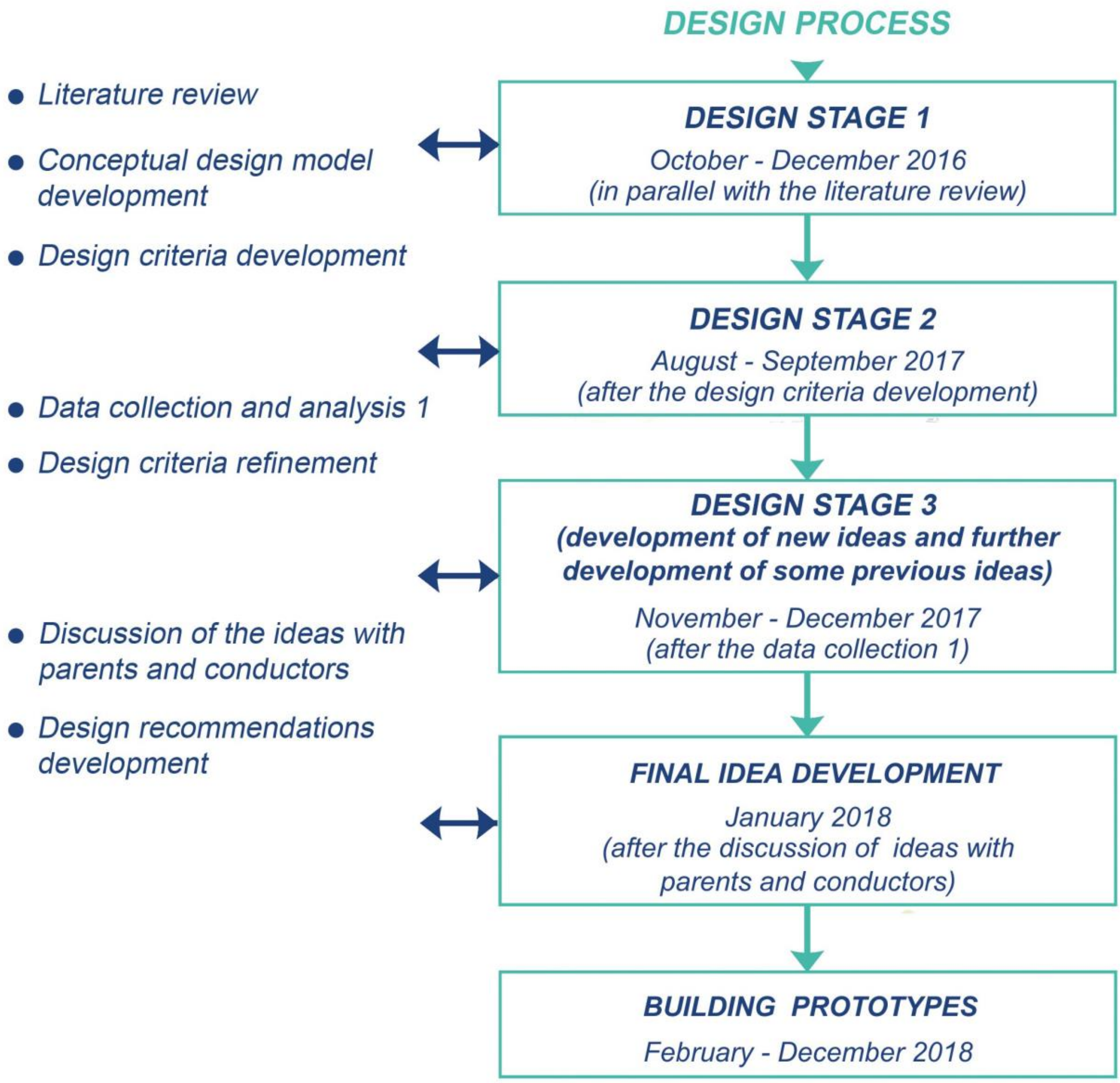


Figure 5.1. Design process

Discussion of the design ideation (design stages 1, 2 and 3 on the diagram) are presented in the section 5.4; final idea development is discussed in section 5.5; prototyping is in section 5.6.

5.4 Design ideation

Design ideation consisted of three stages. Design stage 1 took place in parallel with the literature review. Through this stage, ideation was used as a process of thinking about and exploring joint activities for a group of children and possible concepts of the toys for those activities. Hand sketching was a quick and convenient way to represent the conceptual ideas and to explore the suitability of physical properties of the toys. Examples of the ideas developed during this stage are shown in Figure 5.2 -Figure 5.6. Thinking through sketching, together with this theoretical inquiry, led to the development of the conceptual design model, discussed in section 2.4.1 and refined in section 5.2.

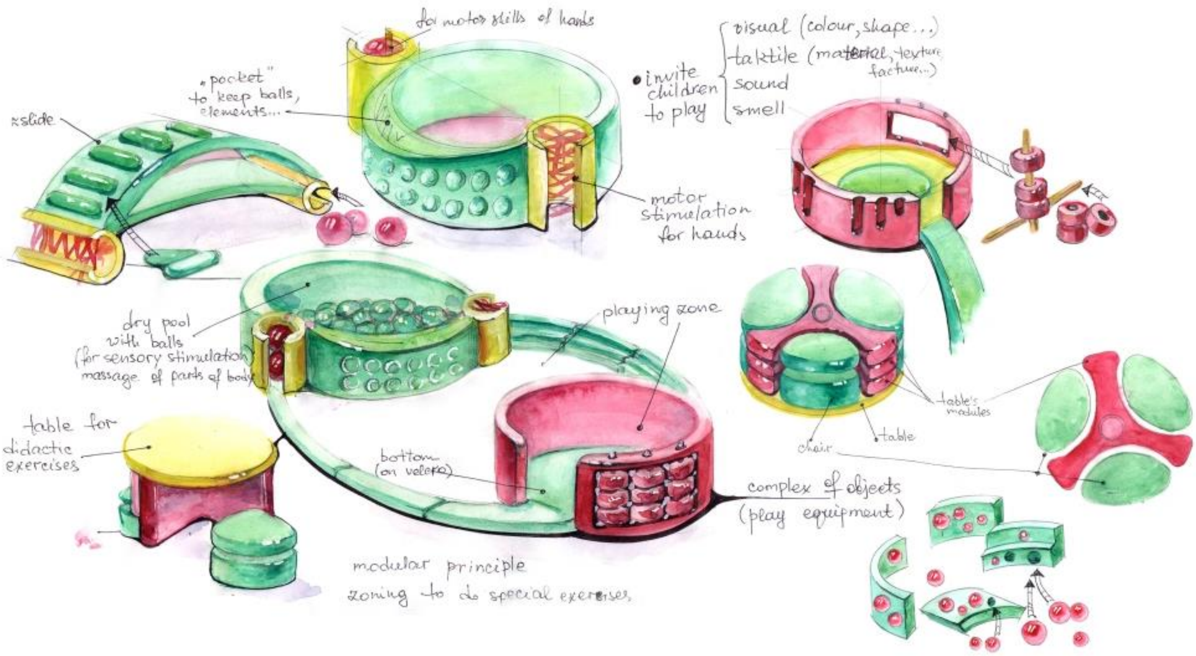


Figure 5.2. Soft indoor playground. It consists of transformable modules which can be grouped in different ways for different play activities. The idea was to create a stimulating, safe and physically appropriate play environment for children to play together.

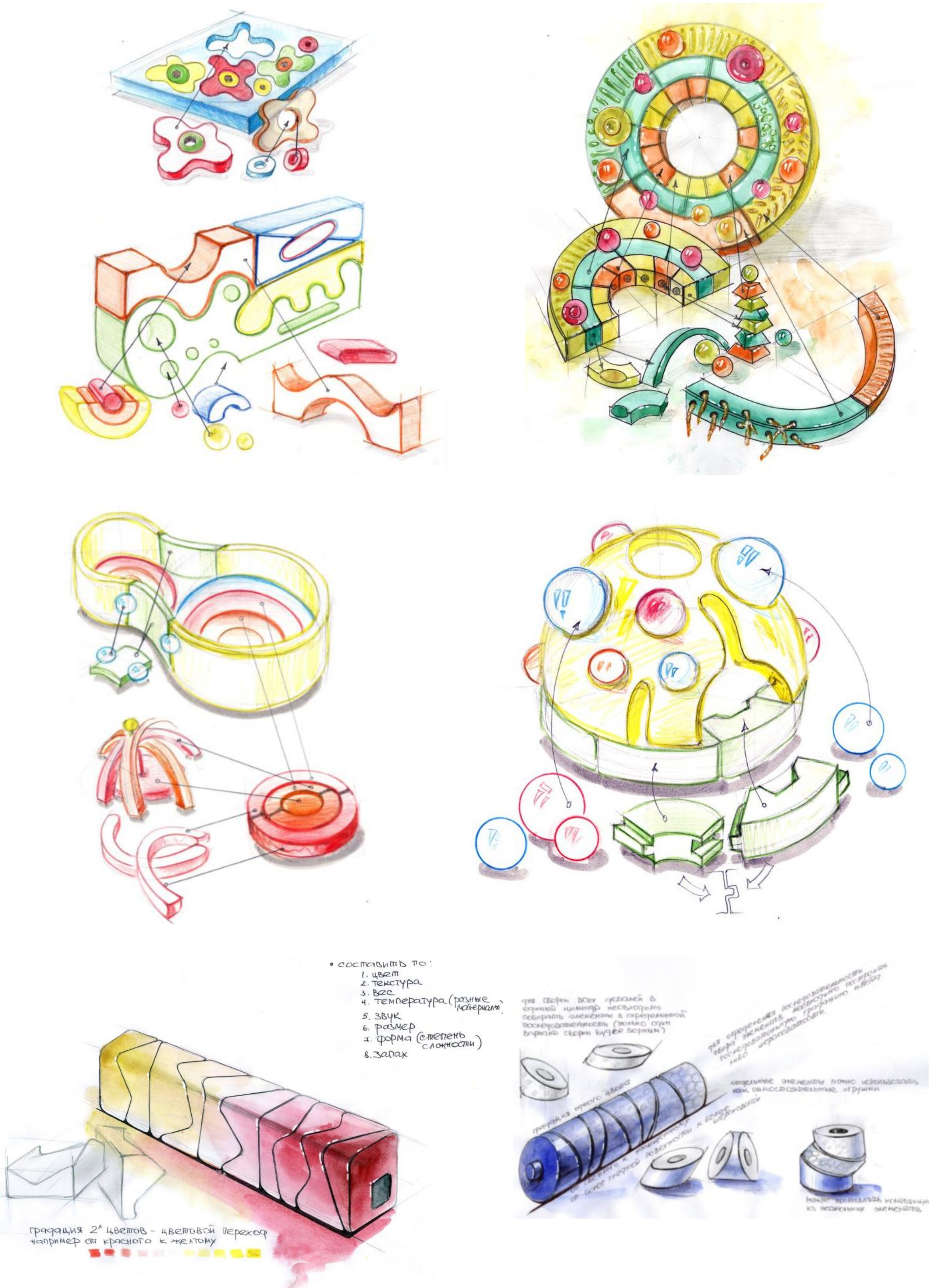


Figure 5.3. Modules for a soft playground. These soft modules can be used as parts of the playground or as independent didactic toys for children’s holistic development.

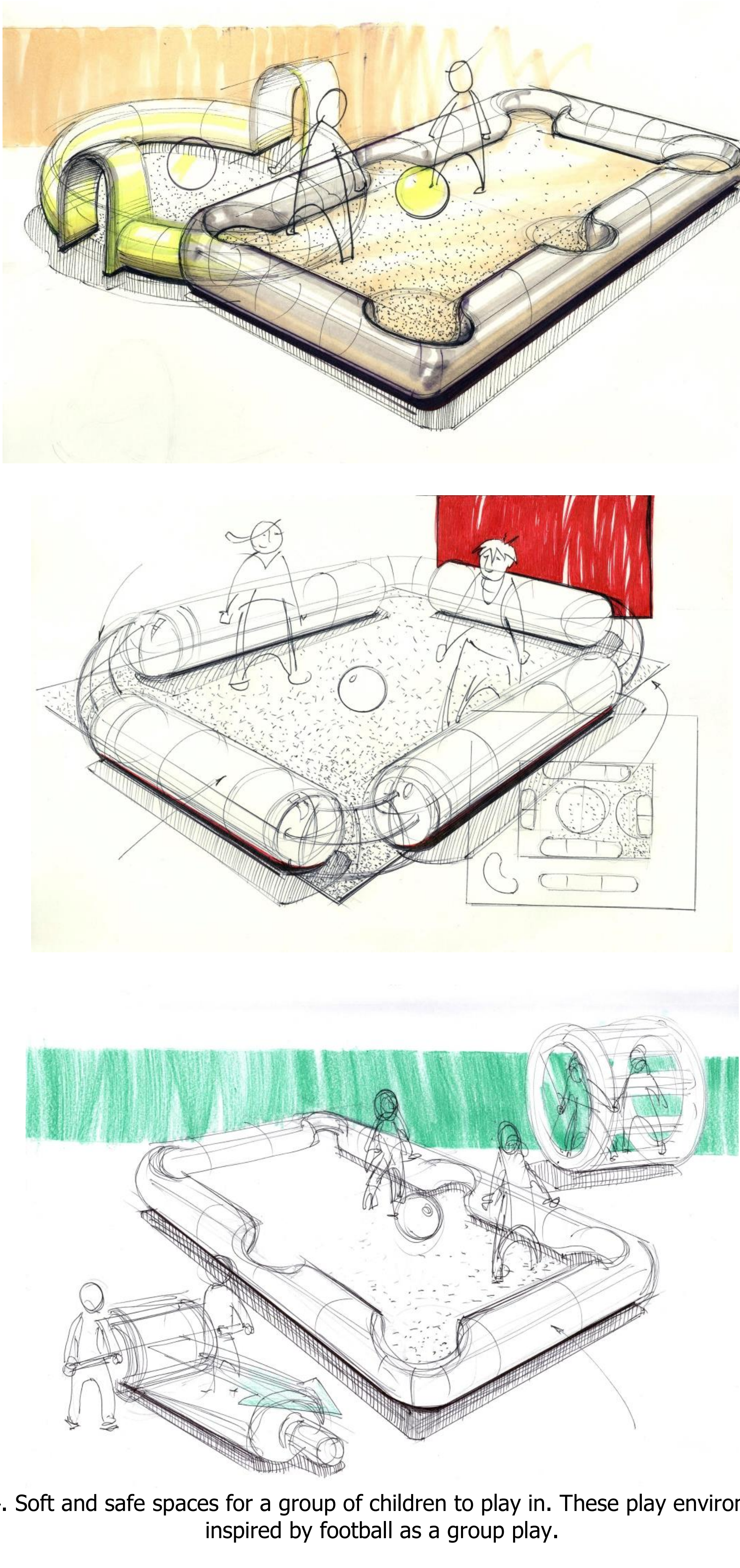


Figure 5.4. Soft and safe spaces for a group of children to play in. These play environments were inspired by football as a group play.

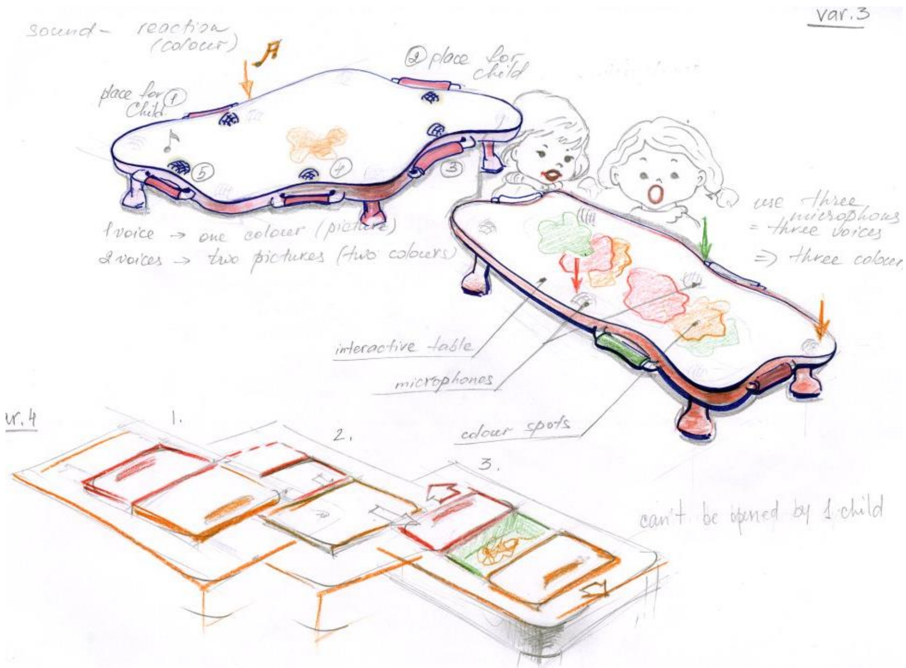


Figure 5.5. Interactive table with multi-touch technology for a group of children to practise cooperation. Touch triggers simple image on the screen. The more touches, the more complex and colourful image appears.

Figure 5.6. 'Look at me' is a set of colourful t-shirts with mirrored surfaces on them. To see own reflection, a child would need to approach another child, as looking in own mirror would be inconvenient.

Design stage 2 started after the development of the conceptual design model and design criteria of the play equipment, which became a basis for the next stage of ideation. Four brainstorming sessions were used to generate conceptual ideas for play equipment that would capture as many of the criteria as possible. The ideation process at design stage 2 was more analytical than at stage 1 but at the same time it was without detailed elaboration so as not to stifle imagination. Figure 5.7 - Figure 5.15 represent examples of the design ideas developed during this stage.

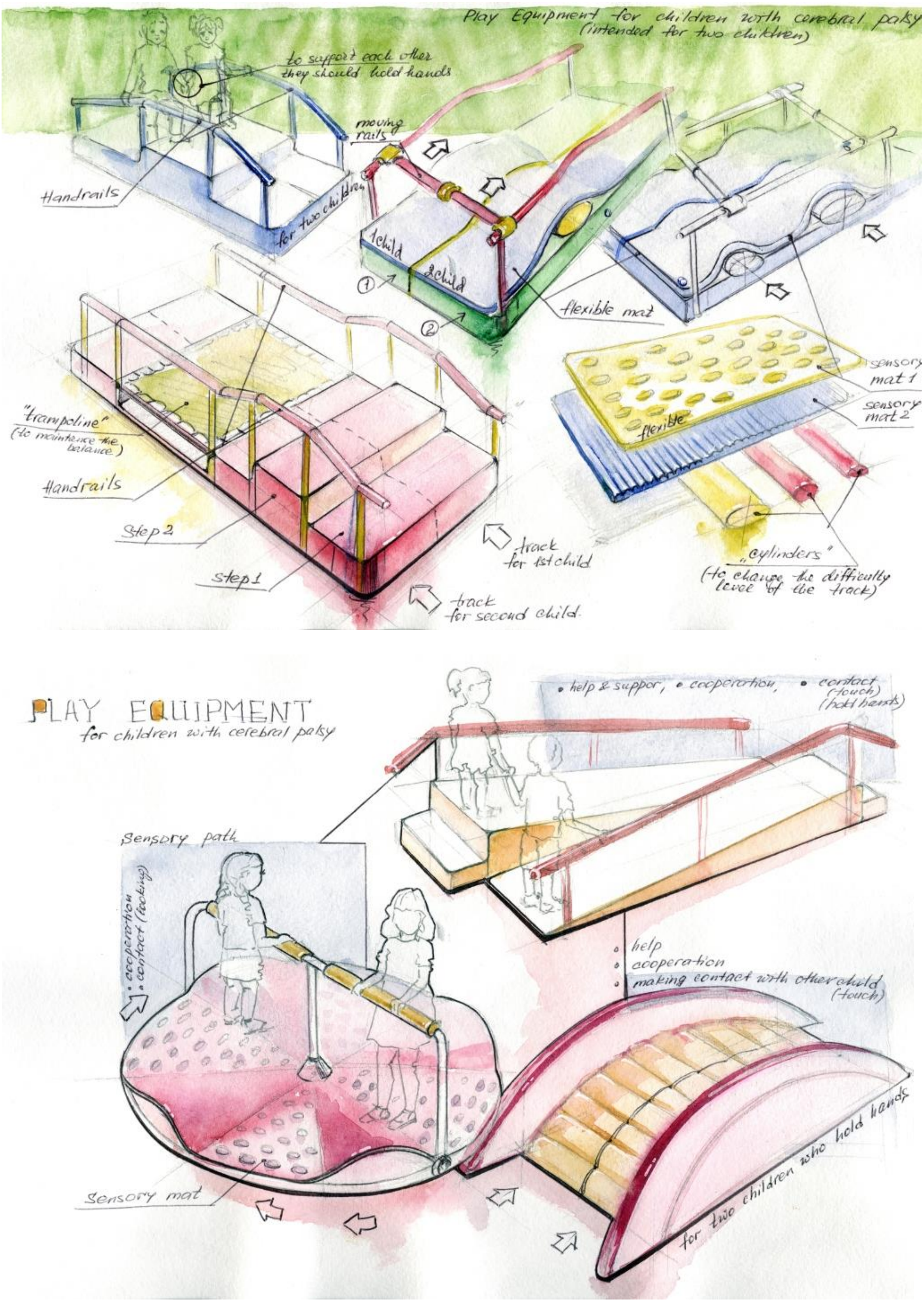


Figure 5.7. Redesigned steps for joint use by two children simultaneously. The steps have rubber mats to avoid slipping and handrails to keep a balance.

The idea development started from redesigning existing play equipment already available at NICE (for example, the steps which are shown in Figure 5.7), where a new function for practising social skills was added to the original one. After further consideration it became clear that the existing functions would overpower flexibility of the play equipment. In addition, focusing on the existing functions, which were often related to physical development, would not allow for full development of relational play. Such play equipment also would not be fully inclusive as children have different levels of physical development. Therefore, the design development moved from redesigning existing toys to creating new ones which would not only allow joint use but also require it and which would minimise physical restraints.

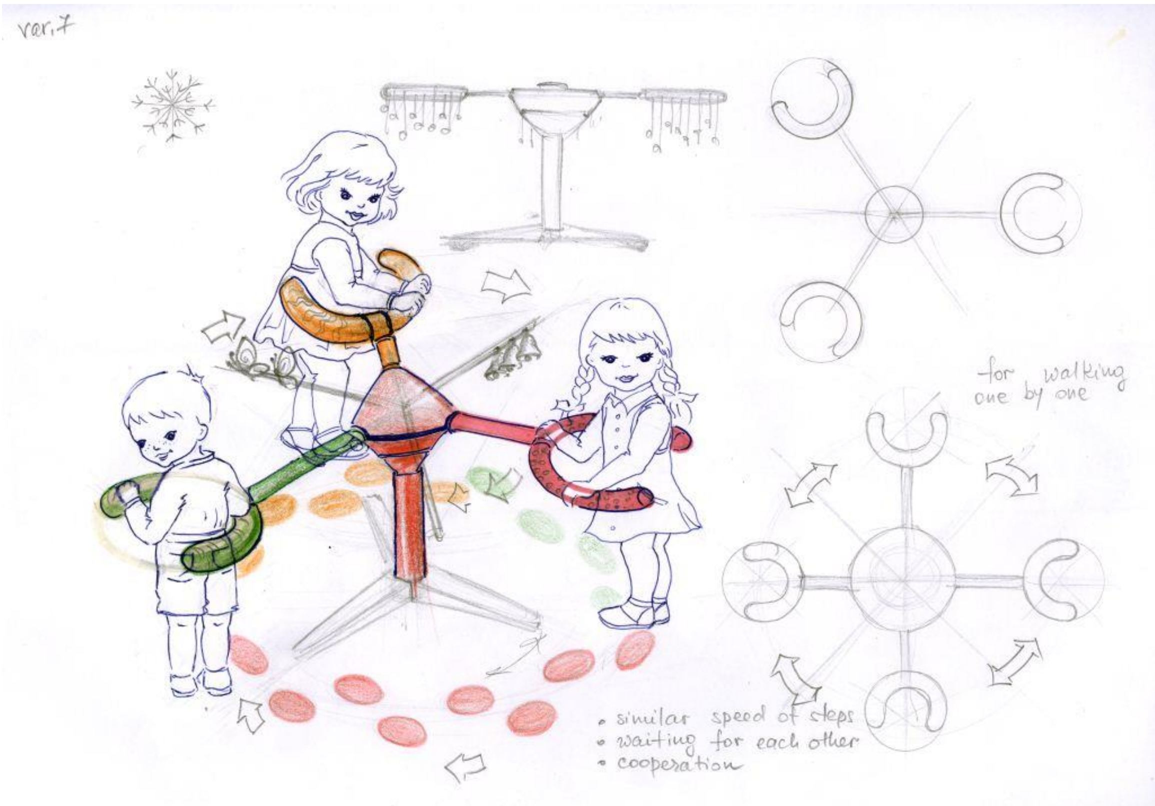


Figure 5.8. 'Funny walk' for practising cooperation

Figure 5.9. Play equipment 'Undersea' with sea creatures inside a sphere. Pushing the handles would cause bubbles inside the sphere. The more children cooperate, the more bubbles they would create.

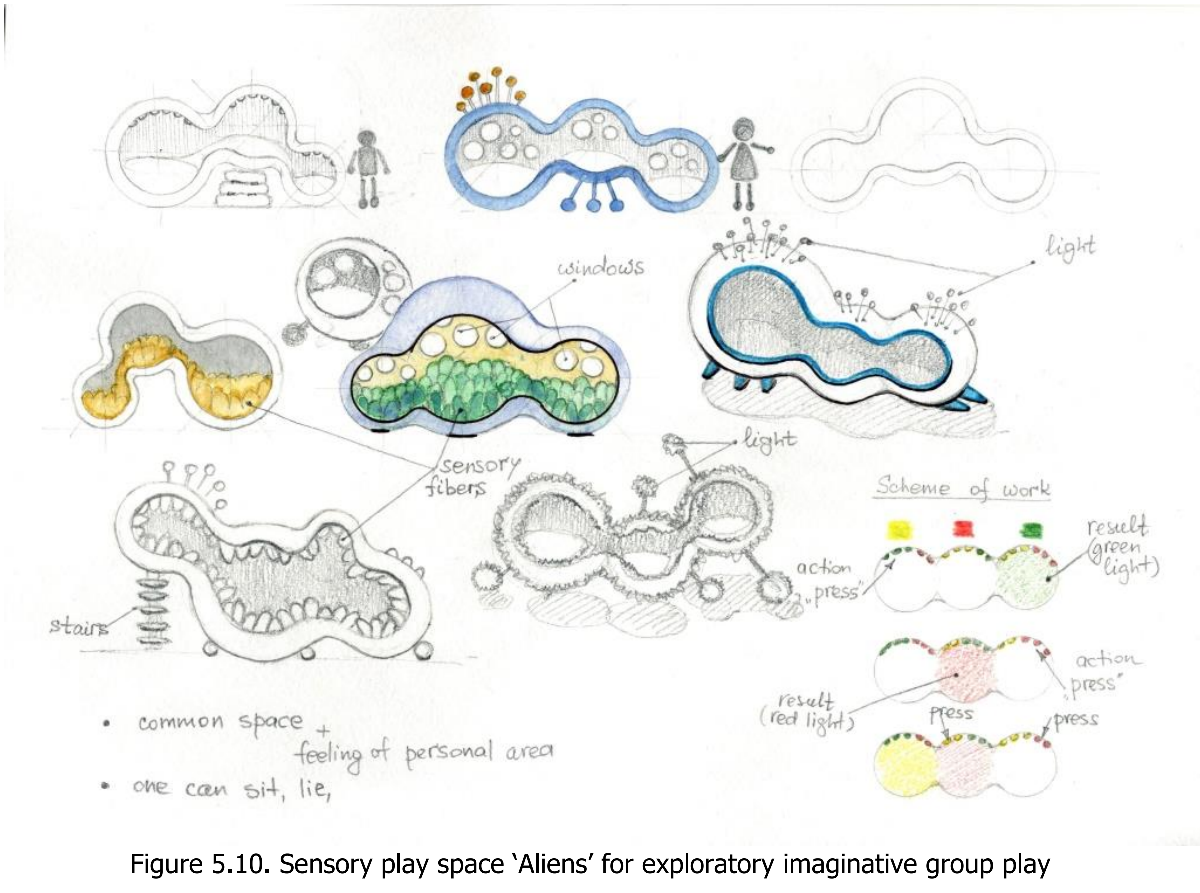
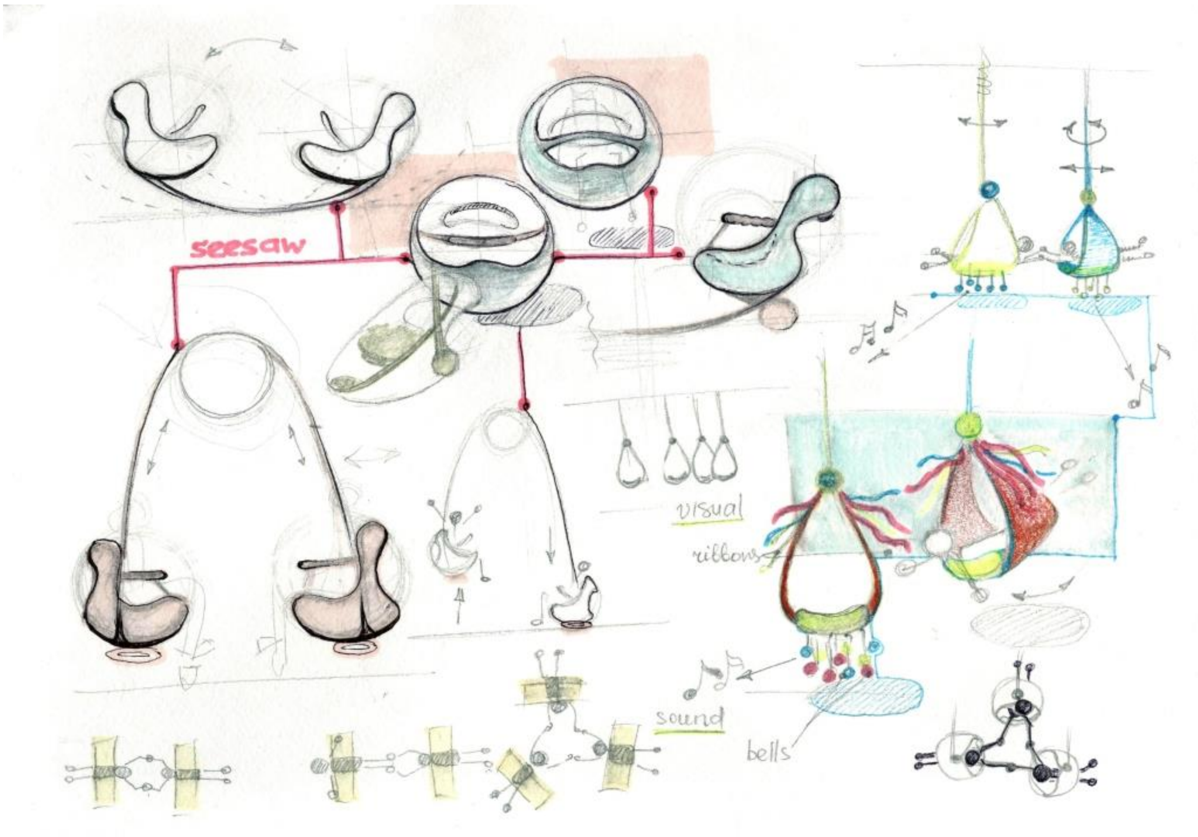


Figure 5.10. Sensory play space ‘Aliens’ for exploratory imaginative group play



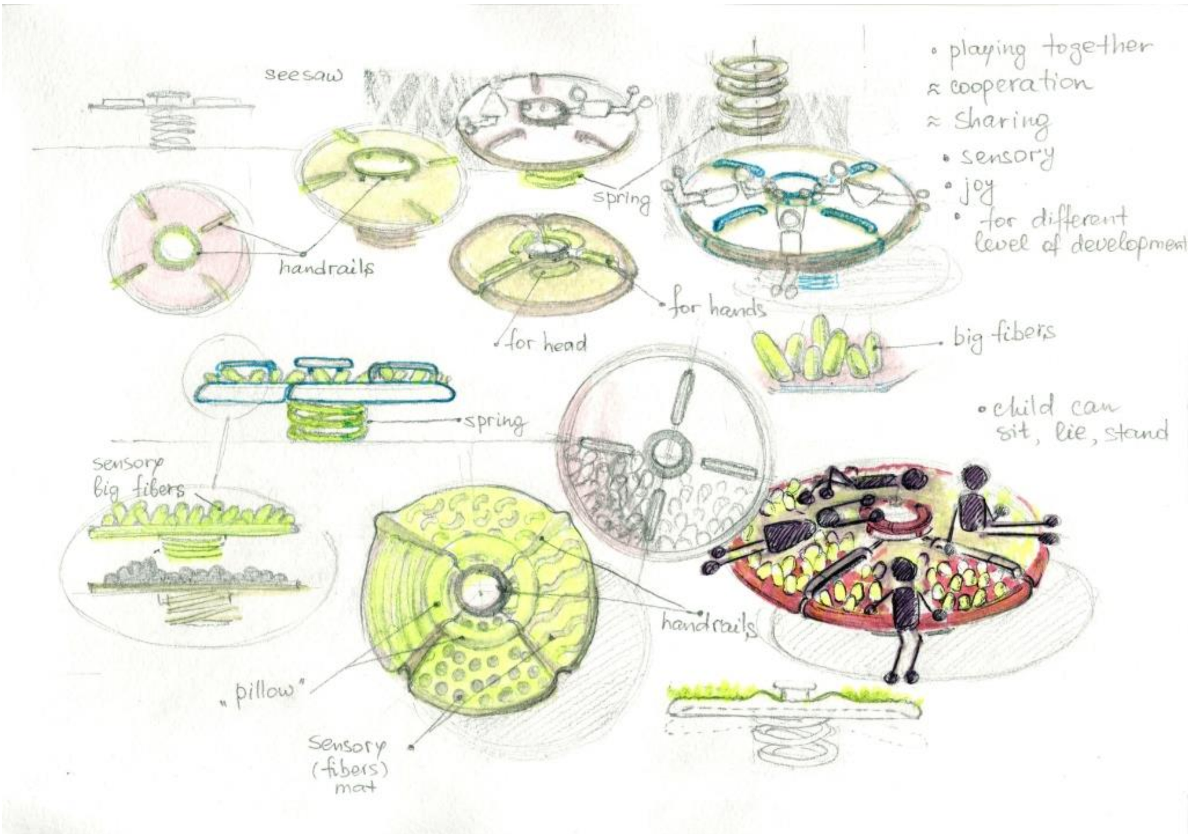


Figure 5.11. Swings for joint use

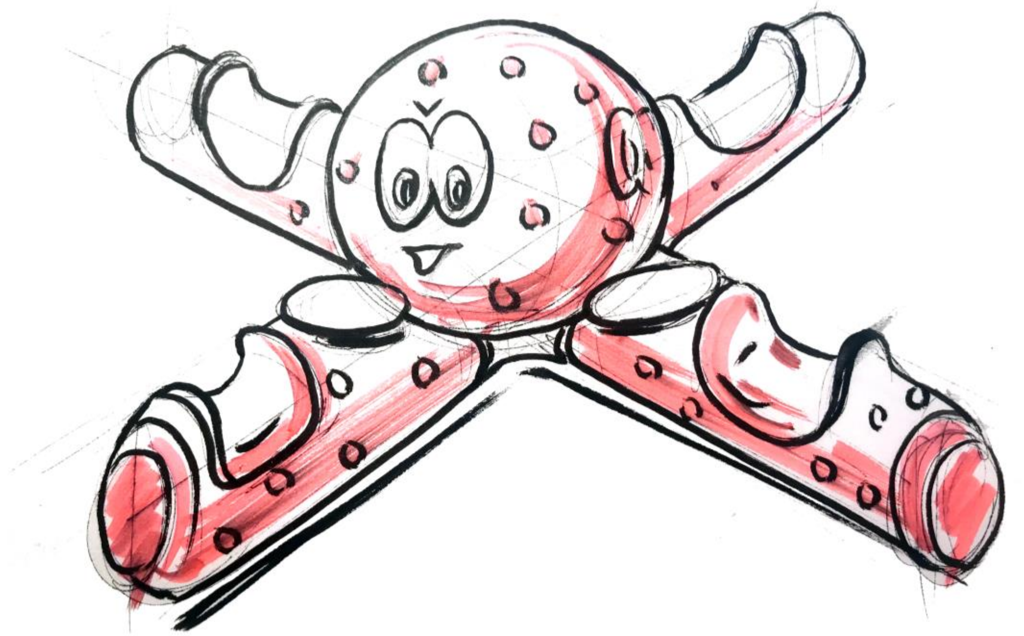


Figure 5.12. Trampoline swing 'Octopus'

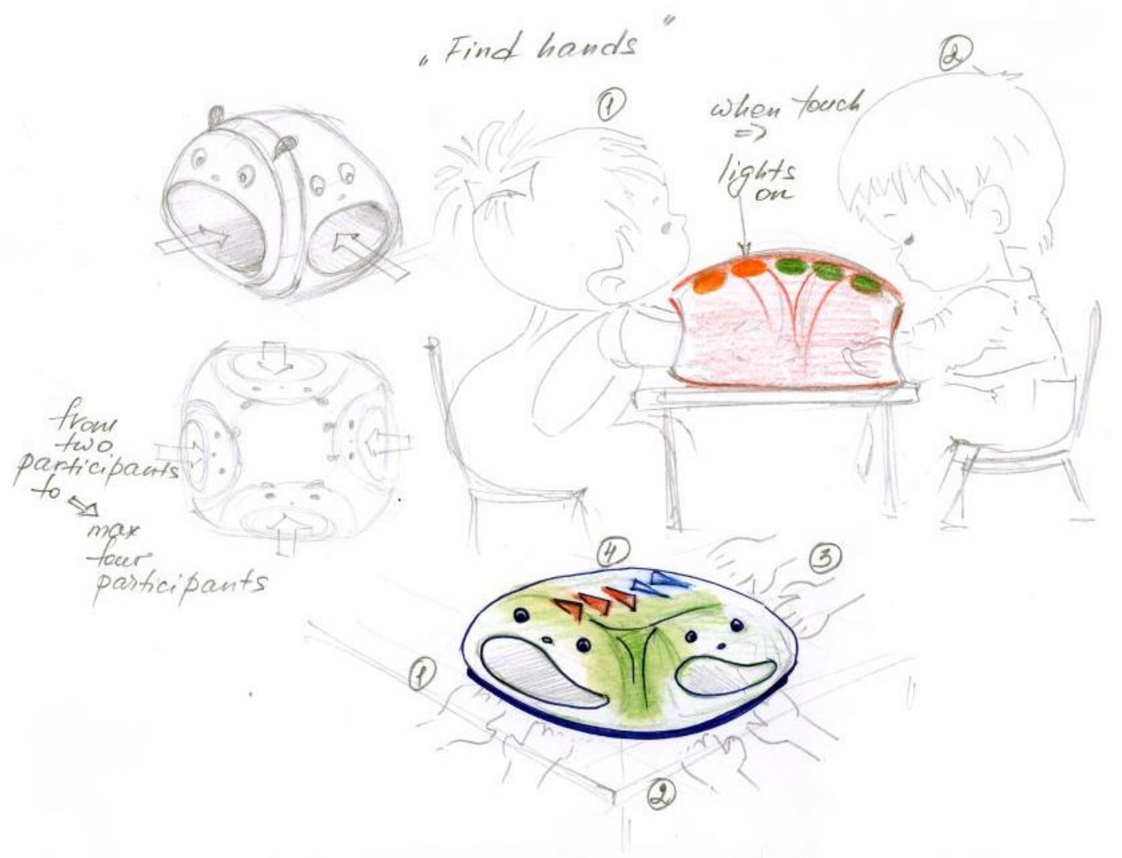


Figure 5.13. Soft toy 'Find my hands'

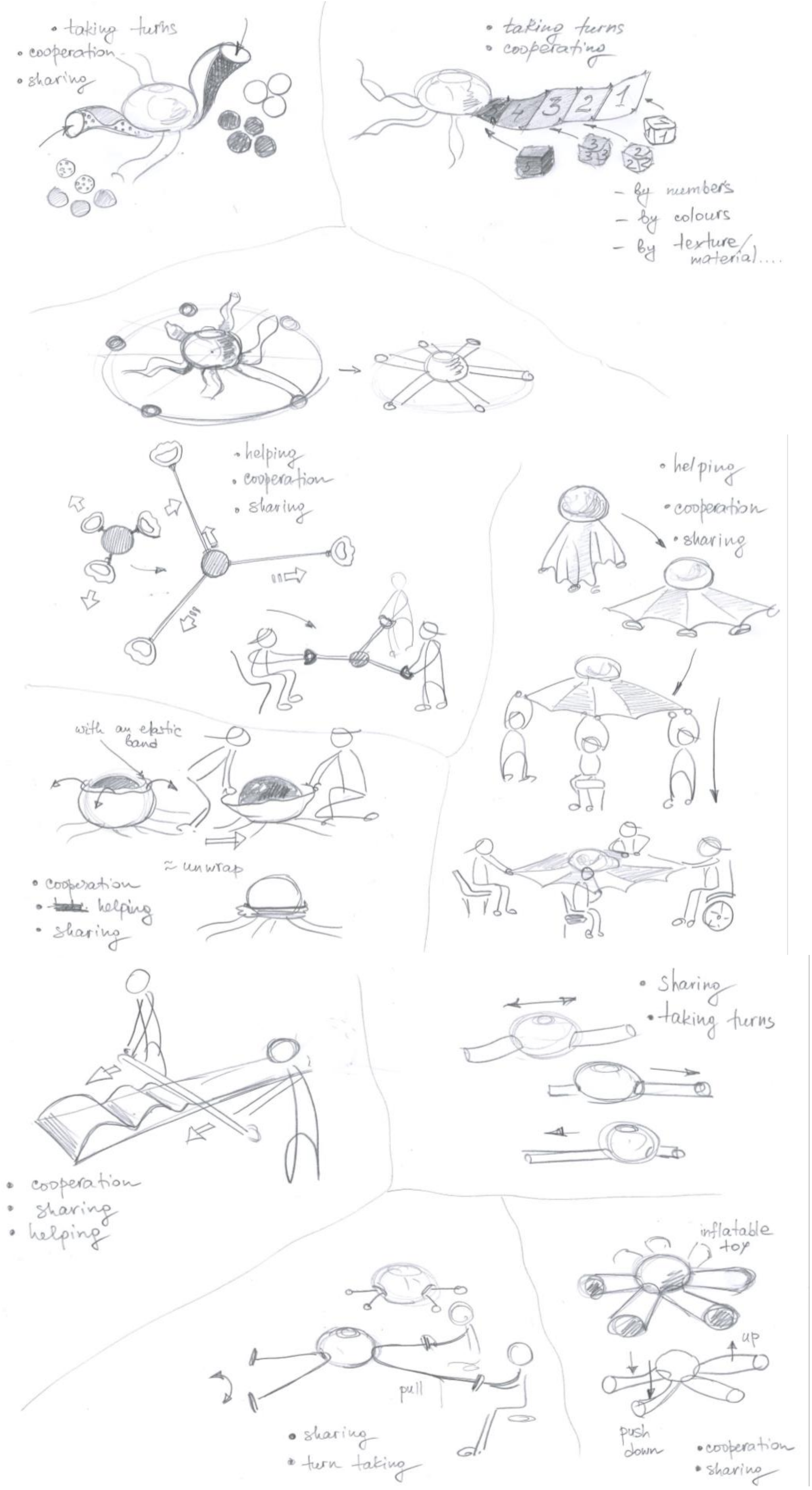


Figure 5.14. Ideas of play scenarios for practising sharing, turn taking and cooperation.

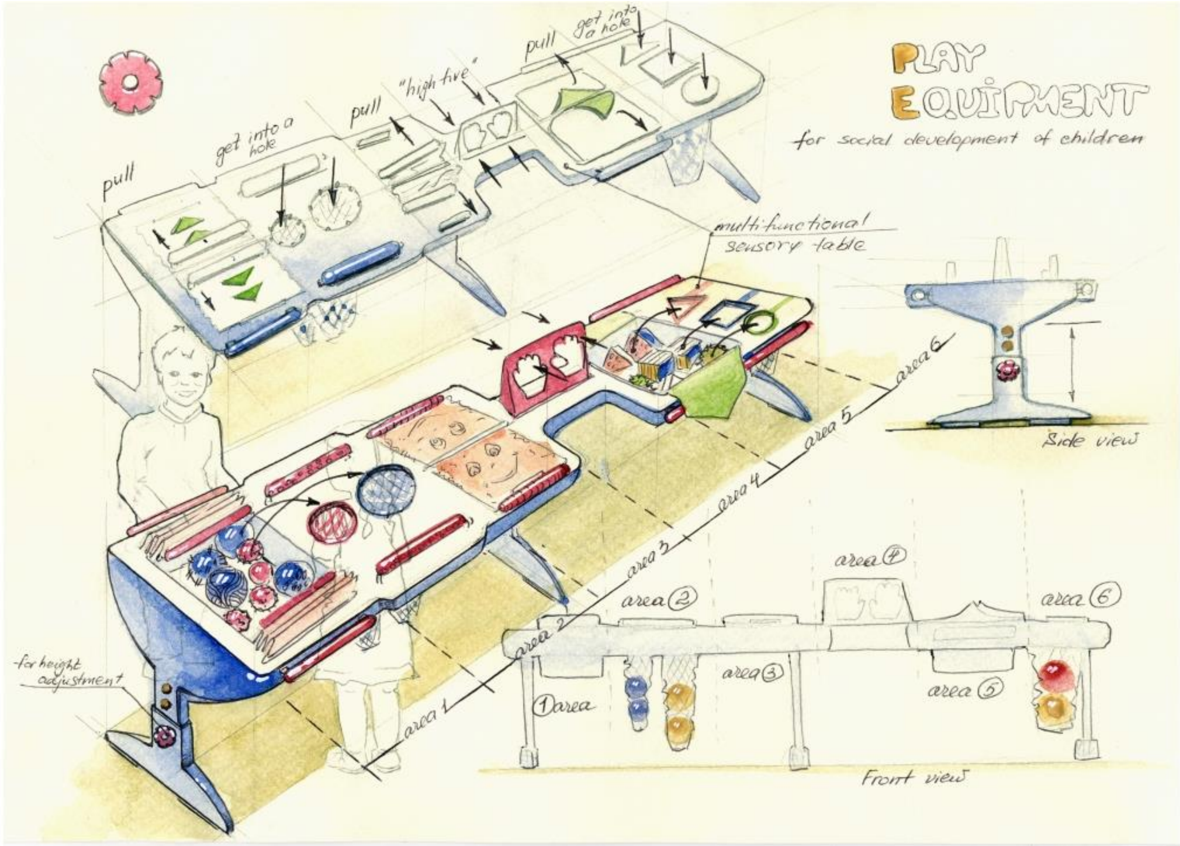


Figure 5.15. Play table with zones for different joint activities.

Design stage 3 took place after data collection 1. Findings (discussed in section 4.6) allowed refinement of the design criteria developed earlier and formulation of more specific design recommendations. Previous ideas were analysed for compliance with the recommendations and criteria, and new ideas were developed. Those which fitted best with the conceptual design model, criteria and recommendations were advanced further. While some of these seemed to fit well with engaging children in relational play and their practising of social skills, new issues remained open, such as how to bring in imaginative aspects and how to keep children's attention for longer, so they would wish to play day after day. To this end, it was decided to shift the approach of designing one toy, with its inherent limitations, to creating a set of toys in a whole play environment, where each object would encourage children to practise one or more particular social skills. Examples of the ideas developed during this stage are shown in Figure 5.16 - Figure 5.22.

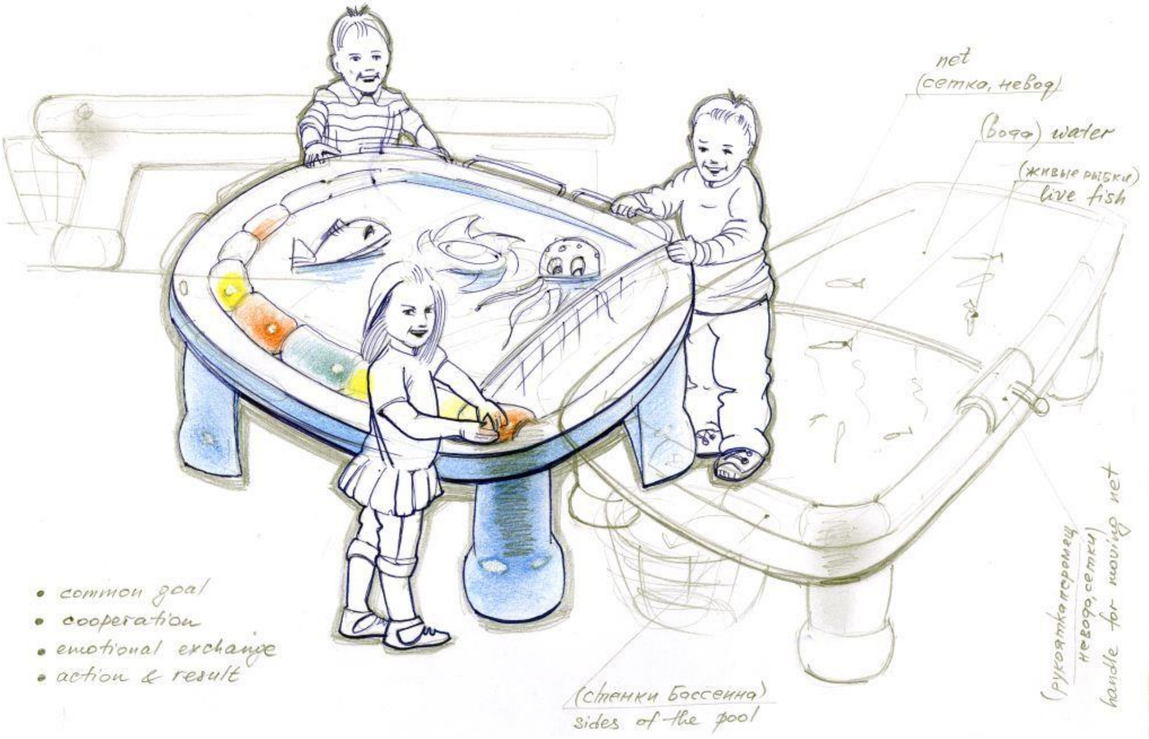
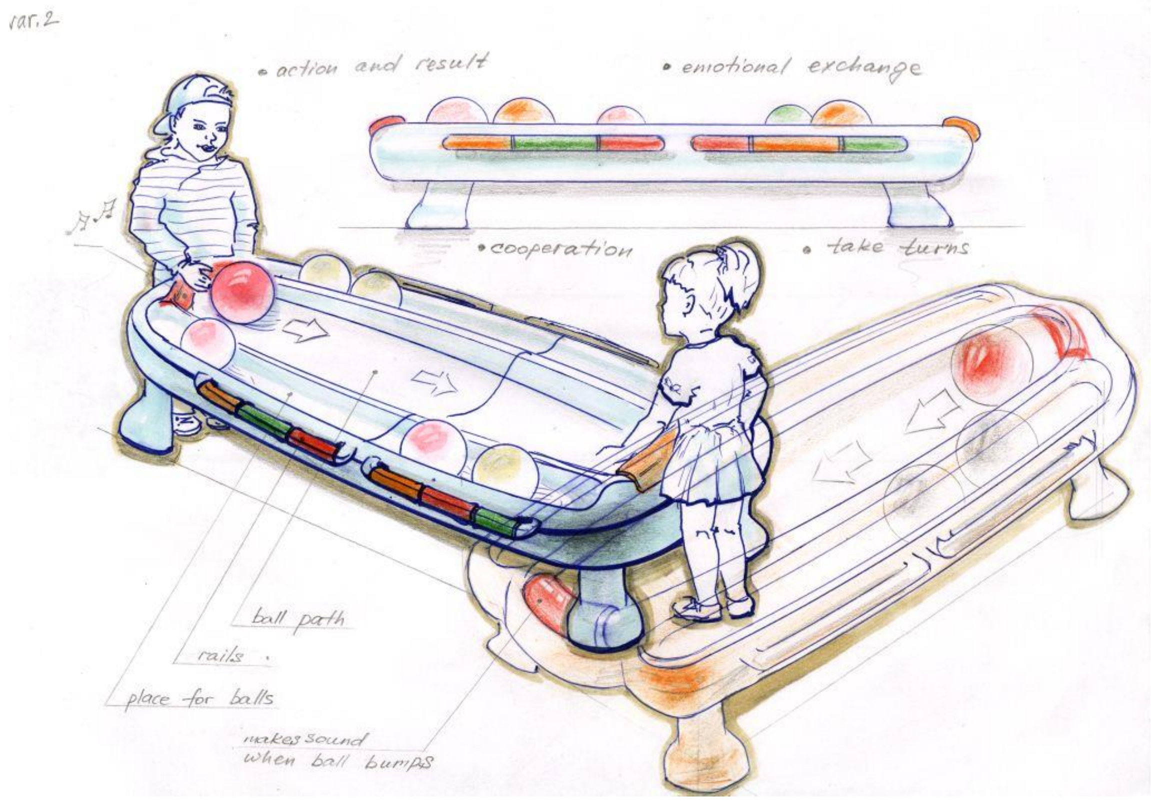
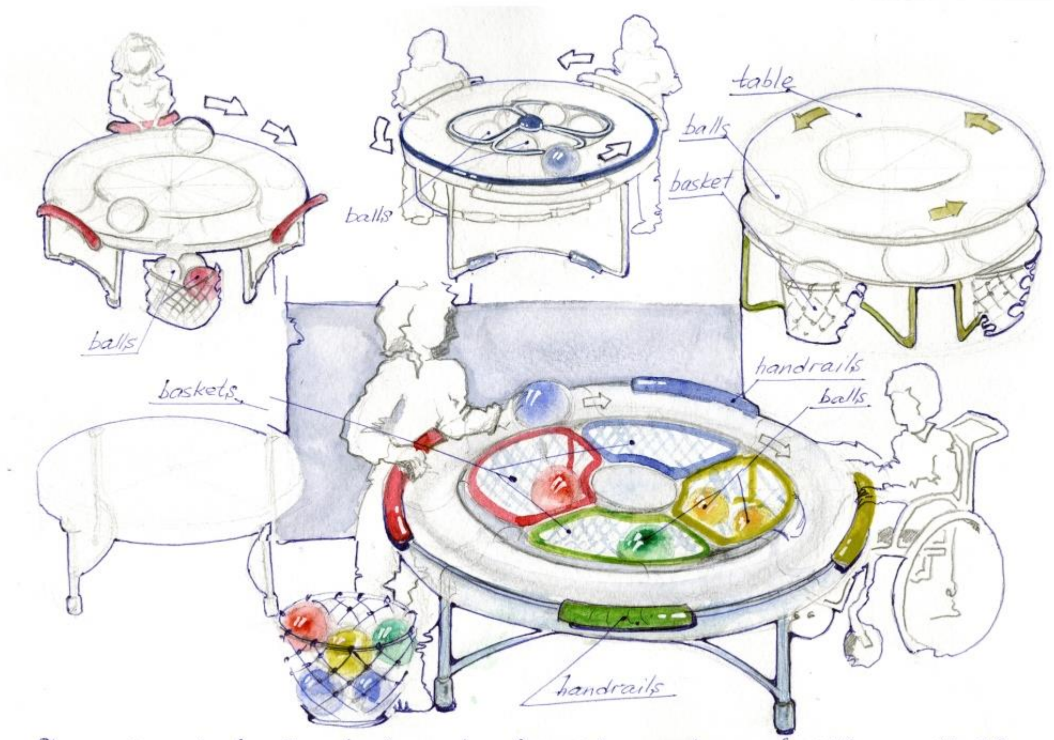


Figure 5.16. 'Fishing'. The idea of a pool with sea creatures came from the play equipment 'Undersea' developed at the previous stage (Figure 5.9). Children should move a net (cooperatively) to catch sea creatures.

Figure 5.17. The development of 'Find my hands' toy (see Figure 5.13). Children should put their hands inside the toy, that is sensory and has various textures to engage them into play. Inside the toy children can find and touch hands of each other. The next level of playing with this toy is to pass the balls through the tentacles to each other.



a)



b)

Figure 5.18. Two variants of the tables for playing with balls as symbols of a social object that often implies the necessity to have a companion to play with. For children it may be difficult to throw or even to hold a ball. Therefore, idea a) is to roll a ball in a groove to each other to practise sharing, turn taking and cooperation. Idea b) is to push or roll the balls to each other in order to sort these balls in the baskets with corresponding to them colours.

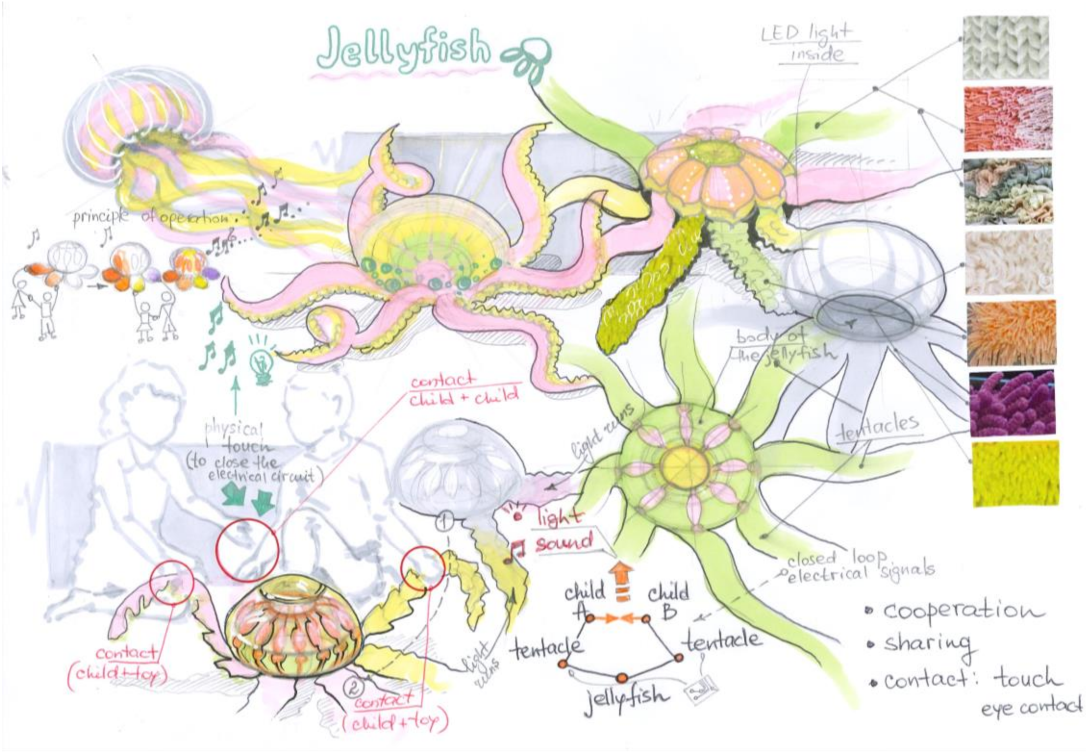


Figure 5.19. 'Jellyfish' toy to encourage touch contact between children. The idea of the toy is that Jellyfish with tentacles form an (open) electrical loop. To close the loop and, thus, to get a feedback (illumination and sound), one child must touch a tentacle and a hand of another child.

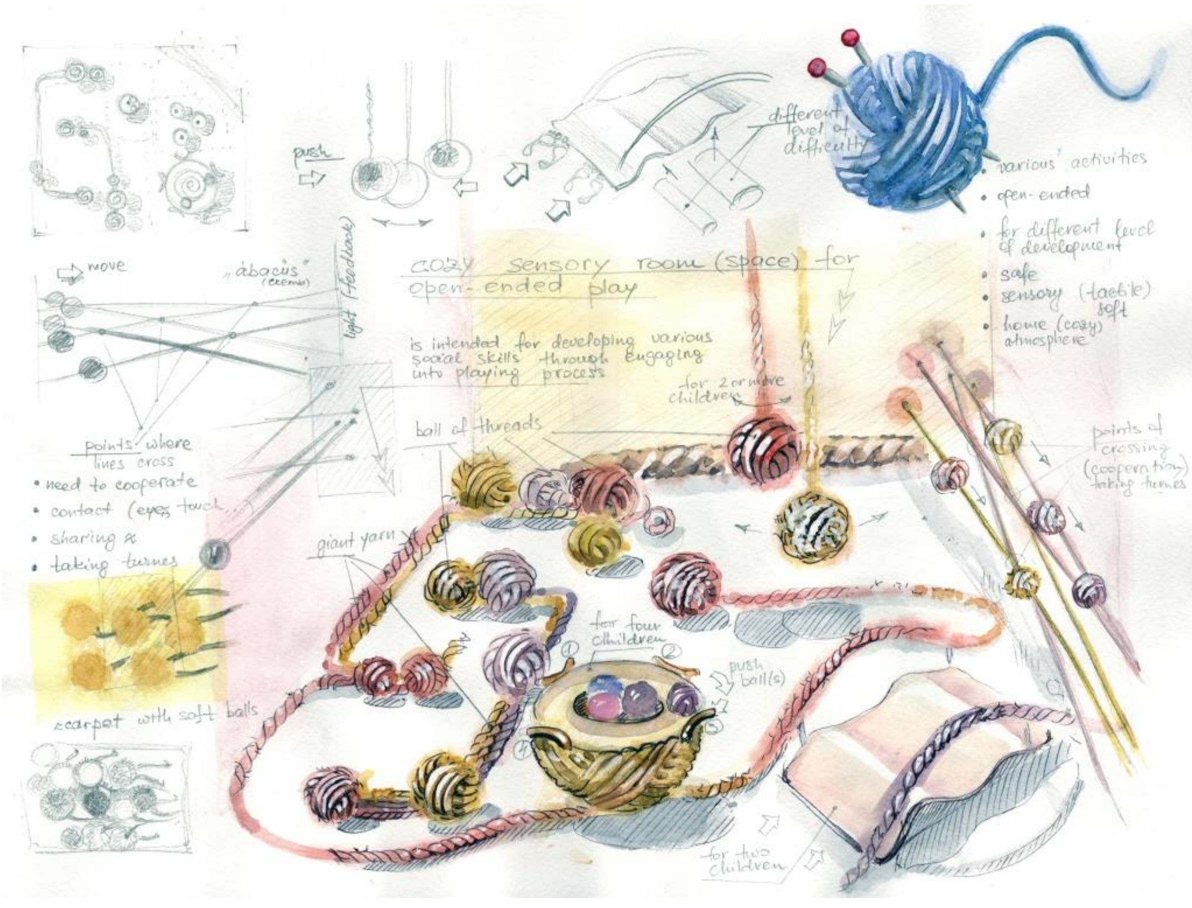


Figure 5.20. Sensory play environment 'Unwind balls of yarn'. It consists of zones (modules) for the activities to aid the development of different social skills such as cooperation, taking turns, helping and sharing. Modules can be assembled in different combinations to keep children engaged for longer.

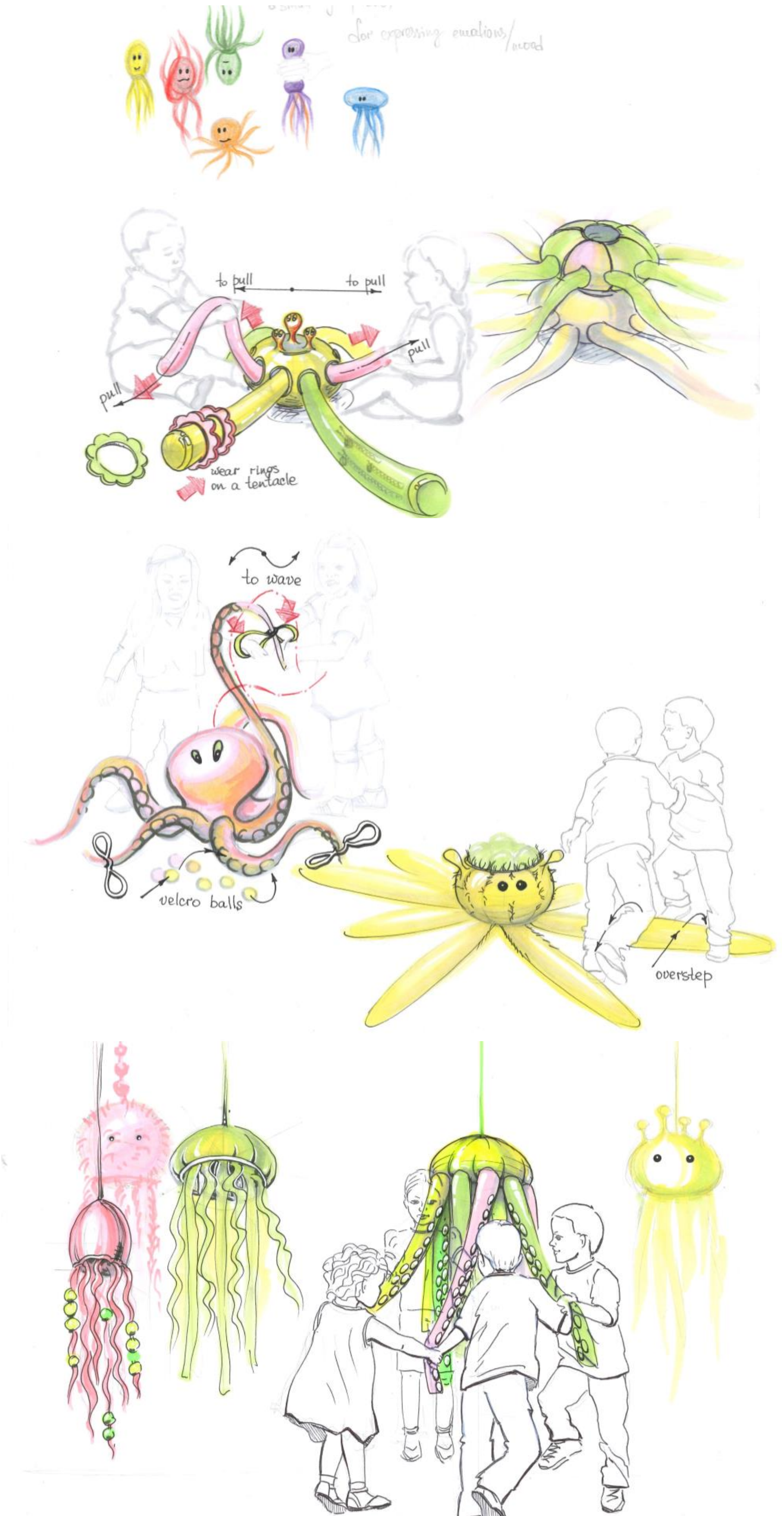


Figure 5.21. The toys originated from the ideas (see Figure 5.14) from design stage 2

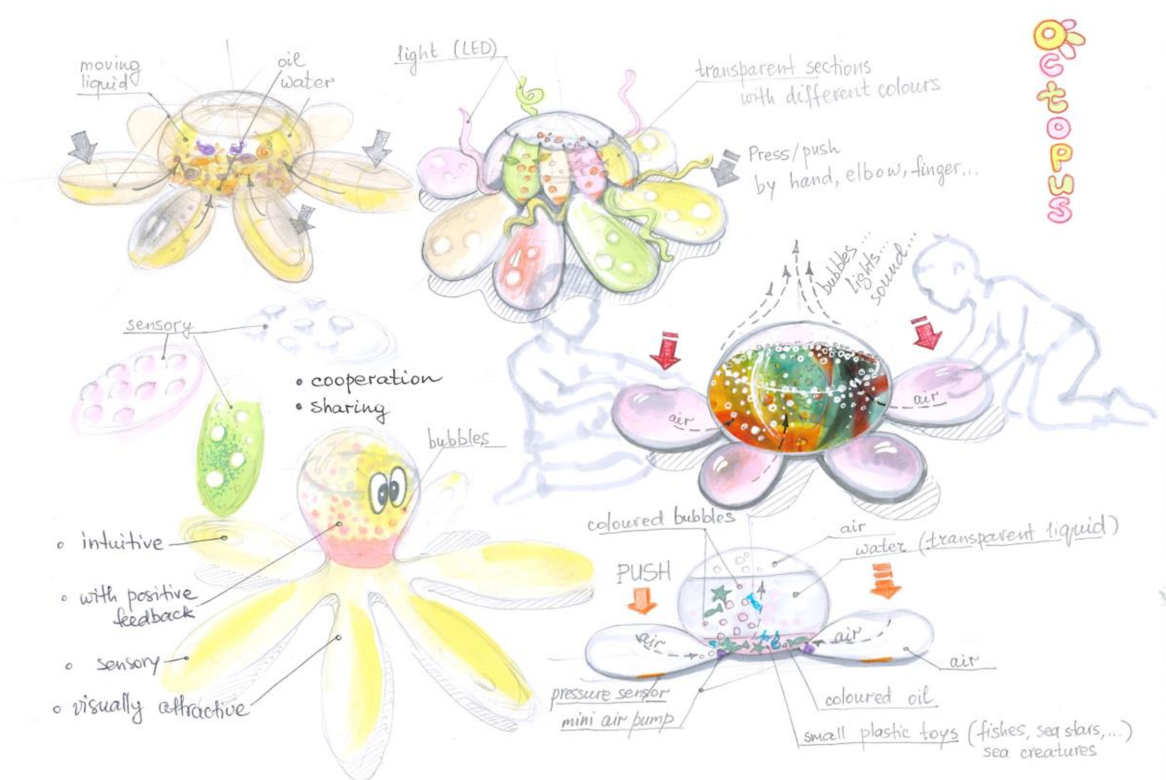


Figure 5.22. 'Colourful octopus' toy to practise cooperation. When a child presses on or pushes a tentacle, it reacts by returning to its original position, while colourful bubbles rise up in the main body of the toy. The more children cooperate, the richer feedback they get. This idea is developed from the toy 'Undersea' (see Figure 5.9)

The sketches from design stage 3 were presented to and discussed with the experts. Based on their feedback, the design development gradually moved to the final idea, discussed in detail in the following section.

5.5 Undersea Friends development

This section is about developing the final idea that was based on creating a complex of toys – "friends", where each toy would be responsible for initiating and practising particular social skills. Thinking about the play environment as a whole, it was important to create artefacts which complemented each other and which would not stand in competition. The toys should form the play environment as a non-chronological whole, where children may enter the play zone from any point. This led to the decision to create a thematic environment with one dominant leitmotif and within which each object in the play space would be both a creature-friend and a facilitator of children’s interactions. Creating the thematic environment with the “live” creatures allowed an imaginary play aspect to be incorporated, and additional properties relating to the expression of emotions included to attract children’s attention.

After three brainstorming sessions undertaken by the researcher during one month, the idea of an undersea world with its inhabitants, such as octopuses, jellyfishes and starfishes, arose. When looking at the shapes of these creatures from a design perspective, all of them have a central element – the body, and several similar repeated elements – limbs. Indeed, all have more than two limbs, for example an octopus usually has eight tentacles, jellyfish may have up to 15 tentacles and starfish have five or more arms. In the context of creating toys for a group of children, the limbs may be perceived as distinct play objects for individuals and the body as a uniting element that brings all children together into a group. There are other species who have six or more limbs, for example insects and spiders. However, these can be rather frightening for children, while sea creatures are usually perceived as more friendly and positive. Moreover, while children have an opportunity to experience birds, insects, and other land animals in their daily lives, it is much harder for them physically to experience an undersea world with its inhabitants. This brought an element of mystery and magic to the theme. The initial ideation of such a magical undersea world is presented in Figure 5.23.

Figure 5.23. Initial ideation of the play environment, Undersea Friends

The next subsections present the development process of the Undersea Friends idea and give a rationale for taking certain design decisions that lead to the final concept.

5.5.1 Appearance of Undersea Friends

Visual perception is dominant among all the human perceptual stimuli (Myers, 1989) and the visual perception of play equipment is a crucial aspect for engaging children (Stern & Robinson, 1994). Visual components include colour, size, form and composition.

According to Friedman and Lennartz (2014), the question of how people perceive visual components as organised patterns or wholes, instead of as many different parts, was raised by Gestalt psychologists in the 1940s. The study of this question formed what are known as "the Gestalt laws of perceptual organization". According to this theory, there are eight main factors that determine how the visual system automatically groups elements into patterns to receive a visual image of the product. These are proximity, similarity, closure, symmetry, common motion, continuity, good gestalt and past experience. These factors describe how a user of a design product perceives it visually.

Crilley *et al*. (2004) define three features of a user's response to visual form: aesthetic, semantic and symbolic. Aesthetic response is about the attractiveness of the product (discussed below); semantic response is about evaluating qualities like function and mode of use (discussed in section 5.52 and 5.5.5); and symbolic response is what the product says about the user (see section 5.5.4).

Aesthetics is a core design principle that defines a design's pleasing qualities. It is used to create perceptive attractiveness and engagement with products. The perceived attractiveness of a toy is connected to its appearance and physical properties (Smirnova, 2014). In visual terms, this includes factors such as balance, colour, movement, pattern, scale, shape and visual image. The visual image of the toy may be characterised as realistic or fantasy oriented (Mertala *et al.,* 2016). A realistic appearance is usually given to toys which replicate real-life archetypes (Hughes, 1999; Nelson, 2005). This feature is dominant when the whole toy is a replica of a chosen archetype, or moderate when it holds a representational element of the archetype.

The attractiveness of a toy is also defined by whether it is familiar to a child and to what degree. Familiar toys are more attractive than new and unfamiliar objects which have no association in the child's personal experience (Smirnova, 2014; Savva 2016). A familiar visual image of a toy will stimulate individual actions in children and the desire to play with it. The most attractive and stimulating toys combine novelty with easily recognizable features.

The toys in the Undersea Friends play environment allowed for a visual image of sea creatures, such as octopus and jellyfish, which children could recognise. However, there was no intention or need to replicate fully the real-life look of those creatures. Making the toys cuddly made them unthreatening and thus more attractive. The main aim was to design a magical dream world with toys-creatures which could express emotions. The appearance of the toys was "toyified" (Thibault & Heljakka, 2018), for example through changing the size and proportions of the creatures and by utilising softly curving surfaces, bright colours, big eyes, etc. These properties are discussed in the following sections.

5.5.2 Play affordances of Undersea Friends

Play affordances are relational properties which are between the action capabilities of children and the physical properties of the play environment, so they are both psychological and physiological. Children as users should be considered as a part of the play environment in which their actions and space are interdependent (Franck & Lepori, 2000; Atmodiwirjo, 2014). The discussion about play affordances, which started in section 2.5.1, indicated that these not only give opportunities for different actions but can also play a role in inviting or triggering particular actions and behaviours amongst those at play.

The understanding of the play environment as a space with action possibilities, with children as actors, suggests that children may adopt their actions to respond the affordances suggested by this environment. Prieske *et al.* (2015) describe an example of different behaviours of children in a playground when they change their actions from stepping over to jumping over a gap in relation to the size of this gap. To this end, action possibilities of the play environment determine not only actions which are affordable but also an effort necessary to perform these actions in the environment. This may be particularly important when designing for disabled children, as their physical abilities vary greatly. To create a play environment which is inclusive for children with different manifestations of cerebral palsy, it was essential to consider physical properties which would be appropriate and accessible to these children within the chosen age group.

To define play affordances of a play environment, the concept of "proxemics interaction" can be helpful. Proxemics show relationships between actors and objects in the space, their influence on each other and their impact on social activities performed (Hall, 1963; Marquez Segura *et al.*, 2018). Marquez Segura *et al.* (2018) discussed proximity distances to describe affordances of the space in the context of designing wearables for collocated social play. These proxemics distances were grouped in terms of proximity to the actor's body as zones: intimate, personal, social and public (Hall, 1963).

To design the play environment, Undersea Friends, it was therefore important first of all to know which play affordances it should provide to perform its main function - engaging children in relational play. For this, it was necessary to consider the physical properties of the toys in relation to the children's bodies and their action capabilities. The categories of Hall (1963) were used to define some features of these physical characteristics.

The size of the toys had to allow children to be in between the personal and the social proxemics zones while playing (see Figure 5.24). Thus, the distance between the children had to be between 46 cm (the beginning of the personal zone) and 2.1 m (the end of the close phase of the social zone). Therefore, the size of the toy had to be not too small, so the children would not be able to play alone or play with each other within their intimate zone. At the same time, it was important that the children could hear each other well, see each other's facial expressions and be able to touch the toy and each other.

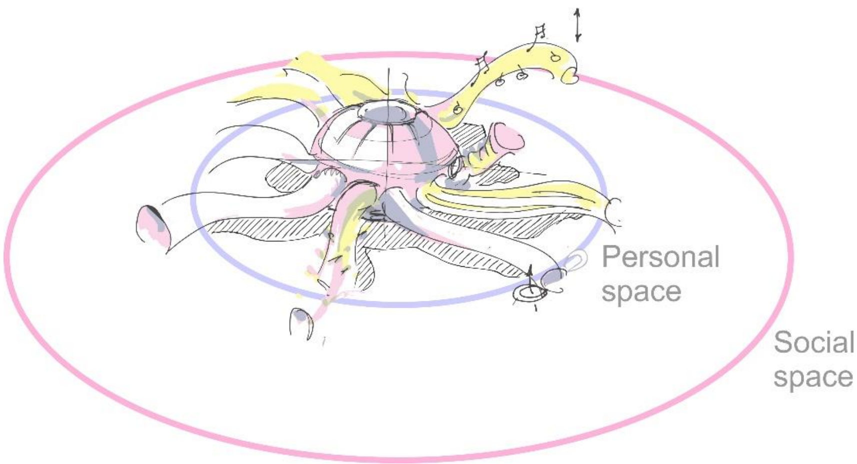


Figure 5.24. Proxemics zones

The other important points in defining the design features of the toys were children's bodily orientation when they were engaged in play, and the direction of their attention. For example, it is recognised that face-to-face communication is more friendly than side-to-side (Prieske *et al.*, 2015). This led to the decision to create toys where children gather around it, facing each other while playing (Figure 5.25). In this way, children would also be in safe, stable and supported positions, as conductors could physically assist them from the back.

Figure 5.25. Children's bodily orientation during play

The positioning of a child's body in relation to a toy also suggests the direction of movement. Development of the physical features of toys requires understanding of how certain play actions can be triggered and supported. However, defining those characteristics for an environment consisting of multiple toys becomes even more complex. A combination of several toys forms a set of affordances in a sequence. Therefore, it was decided to create toys for Undersea Friends with several positioning options for the possibility of multiple play affordances. For example, one toy was designed to be positioned on the floor, so the children could perceive it from above, while the second toy would hang from above, so that the angle of perception would be from below and the space underneath would provide additional affordances, for example, for crawling or walking under it.

Further discussion of play affordances, about ergonomics considerations and parameters of the play environment which make the environment child-friendly and affordable, is presented in section 5.5.5. The next section below discusses an intersensory approach as a means of inviting and engaging children in play activities with the toys. It also shows how intersensory media channels may suggest affordances and sometimes triggers for particular play actions.

5.5.3 Intersensory engagement of the Underwater Friends

In order to engage children in play, the play environment created was based on an intersensory approach. Leeuwen & Ellis (2007), in their development of an interactive environment for elderly people, used the term "intersensory" environment, instead of multisensory, to indicate the relation between different sensory stimuli.

The multisensory approach to designing is employed in multisensory rooms or Snoezelen rooms. These environments are mainly the spaces for relaxation and also create sensory stimuli to supplement or compensate for insufficient stimulation. There is usually no expectation of action from users in this kind of environment (Lee & Dilani, 2008) and although such spaces can provide varied visual, audio and tactile stimuli, these are not connected with each other.

Leeuwen & Ellis' (2007) "intersensory" approach therefore matched better with the goals of Undersea Friends, inviting the children to engage with the toys, leading them through their play and stimulating their motivation through multiple sensory channels by providing various kinds of feedback on their actions. It was important to incorporate visual, audio, and tactile channels to make the toys engaging and stimulating. However, it was critical to design these stimuli as interdependent options which were activated by children's actions. Therefore, it was decided that tactile interactions with the toys inside the play environment should trigger visual and audio feedback without apparent latency. In this way the stimuli could assist in strengthening children's understanding of cause and effect and help them to feel they had control over their play.

Each toy in the environment had two scenarios of cause-and-effect feedback: individual feedback, when a child triggered audio and visual feedback through his or her own actions, and group feedback, when play participants coordinated their actions and collaborated to trigger sensory feedback. Group feedback was felt to be richer and longer lasting than individual feedback, making children interested and motivated in playing together and collaborating. The cause-and-effect experience was thought to empower children with a feeling of their control over the play equipment.

The audio, visual and tactile stimuli were designed differently in all toys. For example, the design of the first toy envisaged using fabric with a pronounced texture to increase tactile feeling, improve textual awareness and encourage physical contact with the toy. The design of the second toy envisaged using several patterns of a pronounced material texture that might help in developing sensitivity in fingers and keep children engaged in exploration for longer. The material envisaged in the third toy was a combination of TRU filament, used in 3D printing to implement a complex sensory texture of the form, and a smooth, transparent acrylic surface. The play environment therefore consisted of toys with varied tactile stimuli: warm, soft, fluffy to smooth, cold and hard.

It was envisaged that visual stimuli could also be generated in different ways, for example, by using multi-coloured LED lighting in the tentacles and the body of the toys, by incorporating water fountains with additional LED illumination underneath, and by using materials with different textures and colour spectrum. Visual feedback can be quite active in triggering positive emotions and engagement in children (how to trigger positive emotions is discussed in detail in the next section). This is especially relevant for children with cerebral palsy, as excitement may cause movements which are not evident in everyday scenarios, although it may also further increase muscle tone, which would be a negative effect.

To balance the active and bright visual stimuli, the audio feedback of the toys needed to be melodies or songs which were positive but calm and without sudden changes of tempo, volume or timbre of voice. Short melodies without words were chosen for the individual feedback, and lyrics without music were recorded for each toy for the group feedback. The lyrics for the group feedback were performed by Rosie Hayward, a PhD student from Heriot-Watt University in Edinburgh. The songs had simple and easy-to-remember words and melody with repetitions, so that children could sing along with the toys. Practical realisation of the audio, visual and tactile feedback is discussed in more detail in sections 5.5.1 and 5.5.2.

The play environment, Undersea Friends, created for this research, is therefore an inter-sensory complex where visual, audio and tactile stimuli are connected and interdependent. The sensory-motor interactions with the toys lead to different types of audio and visual feedback which appear without a delay. Use of various materials and media tools helps to provide an engaging environment that encourages children's involvement in relational peer play and assists in developing their senses.

5.5.4 Designing for emotions in practice

Emotions play an important role in social interactions with peers. As was discussed in section 2.5.6, emotions may perform communicative and social functions as well as create physical responses, which is important for disabled children. When designing toys which stimulate positive emotional responses and facilitate social interactions amongst children, emotions can be transferred through various features of design objects and by various factors, such as colour, shape, texture and movement. Some of these factors are considered with respect to the design of the play environment below. Three main positive emotions were identified from the discussion in section 2.5.6 as stimuli for the emergence of social interactions: happiness, surprise and joy.

5.5.4.1 Expressing emotion through lines

Simonds & Starke (2013) suggested using lines to communicate emotions through design. Positive emotions can be expressed through 'active' (for instance, curved, diagonal, zigzag) but soft lines without sharp edges. The lines should not be too rough, hard, uncertain or unstable. Positive emotional design uses round rather than square shapes (Um *et al.*, 2012). The attempt to express happiness, surprise and joy through lines in this way is shown in Figure 5.26.

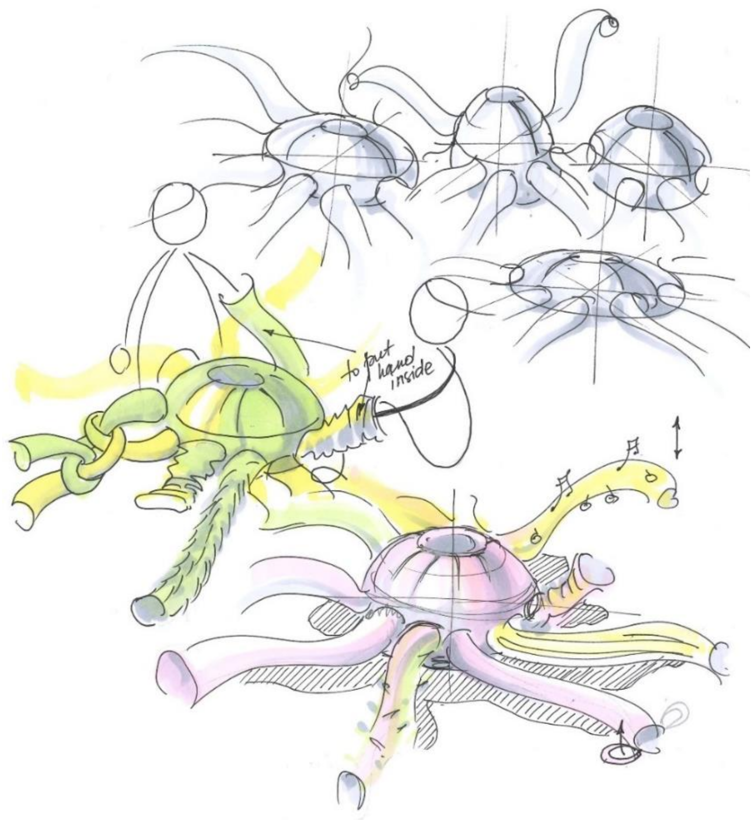


Figure 5.26. Communicating emotions through lines

5.5.4.2 Expressing emotion through colours

The next object feature that may assist in communicating positive emotions through design is colour. Colours have the ability to impact on the emotional well-being of children, by stimulating or calming, exciting or depressing, provoking and antagonising (Weerdesteijn *et al*., 2005).

Goethe (1840) studied the nature of colours and how people are influenced by them. He wrote about colours expressing negative and positive qualities, about yellow being associated with light, brightness, force, warmth and closeness, and blue with deprivation, shadow, darkness, weakness, cold and distance. The colours on the positive side in his system induce an exciting, lively, aspiring mood, whilst the colours on the negative side create unsettled, weak and yearning feelings.

Itten (1973) and Albers (1975) examined colour as a means for interaction. Itten (1973) discussed the cold-warm, shadow-sun, airy-earthy, light-heavy and wet-dry qualities of colours. Albers (1975) described the amount of energy in different colours, where red represents the most powerful and strong emotions, moving along a colour scale towards less energy, ending with blue. Valdez & Mehrabian (1994) conducted a study on emotional reactions towards colour hue, saturation and brightness, relating to pleasantness, arousal and dominance. Boyatsiz & Varghese (1994) found that light colours (such as blue and yellow) were associated with positive emotions, and dark colours (such as black and grey) were associated with negative ones.

Schiller (2014) includes the following ideas for using colour to enhance learning and influence mood: red creates alertness and excitement, encourages creativity and may be disturbing; blue creates a sense of well-being, sky blue is tranquilising;

yellow creates a positive feeling, an optimum colour for maintaining attention, and encourages creativity; orange increases alertness; green creates calmness; brown promotes a sense of security and relaxation; off-white creates positive feelings and helps maintain attention. According to Allegos & Allegos (1999), it is the contrast between colours that allows them to generate an emotional response. Specific combinations of colours are said to produce the best results in terms of appeal and meaning.

Steiner (1995) linked colour theory with the stages of children's development, which he divided into three seven-year cycles. He believed that the learning experience of children from 0 to 7 years should be in a physical environment designed to be home-like, with no sharp corners and decorated in soft tones of pink to create a secure feeling, in pastel colours or in the colours of the seasons. He also highlighted the importance of complementary colours. For example, the excited child surrounded by bright red colour, on the physical level creates the opposite to red – green which has a calming effect.

To sum up, combinations of warm colours, or combinations of warm colours with their complementary colours, elicit greater feelings of arousal than do merely cold colours (Ståhl, 2005). Therefore, to communicate joy, positive surprise and happiness, it is valid to use mostly saturated, bright, warm-colour combinations, including yellow, orange and pink, sometimes in combination with less saturated complementary colours. An example of a toy with such a colour scheme is presented in Figure 5.27.

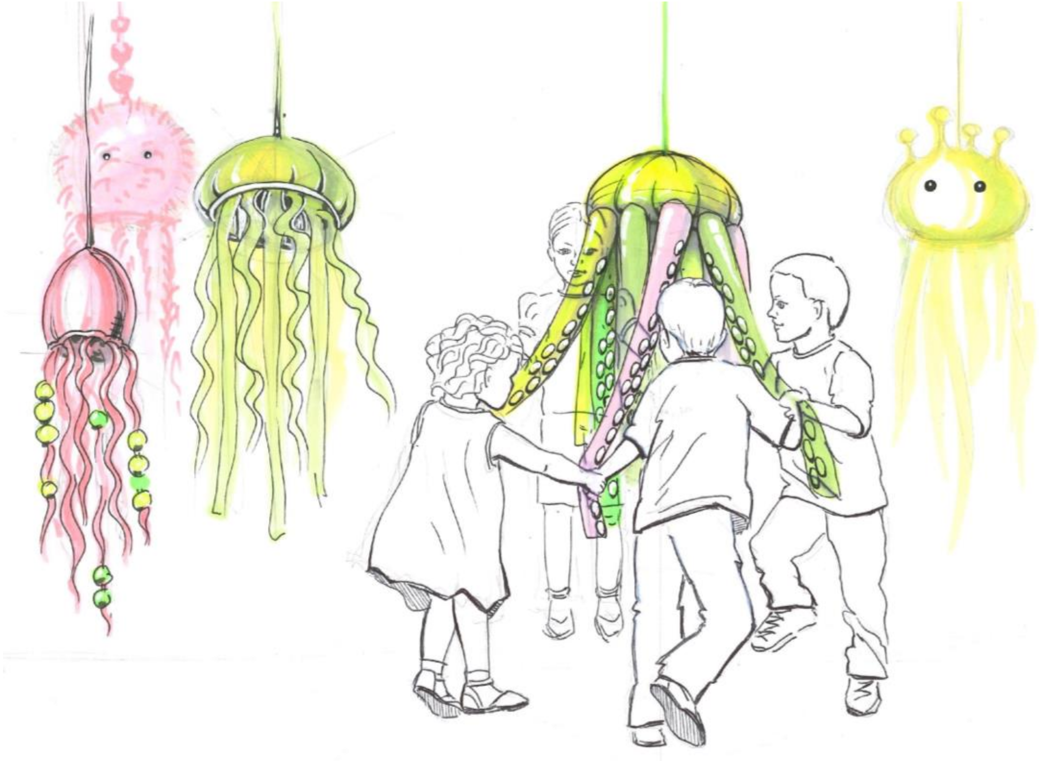


Figure 5.27. Communicating emotions through colour

Another perspective in discussion of the colours of children's toys is to look at the most popular toys for children in the chosen age group in order to analyse the colour palette used by their designers. Kudrowitz and Wallace (2010) investigated toy products popular in 2007. They chose a sample based on reviews and ratings from websites, such as Amazon.com, Hasbro.com, Mattel.com, ToysRus.com and About.com, and developed a scheme where they placed the toys in groups according to the manufacturers' suggestions for age appropriateness and gender affiliation (presented in Figure 5.28).

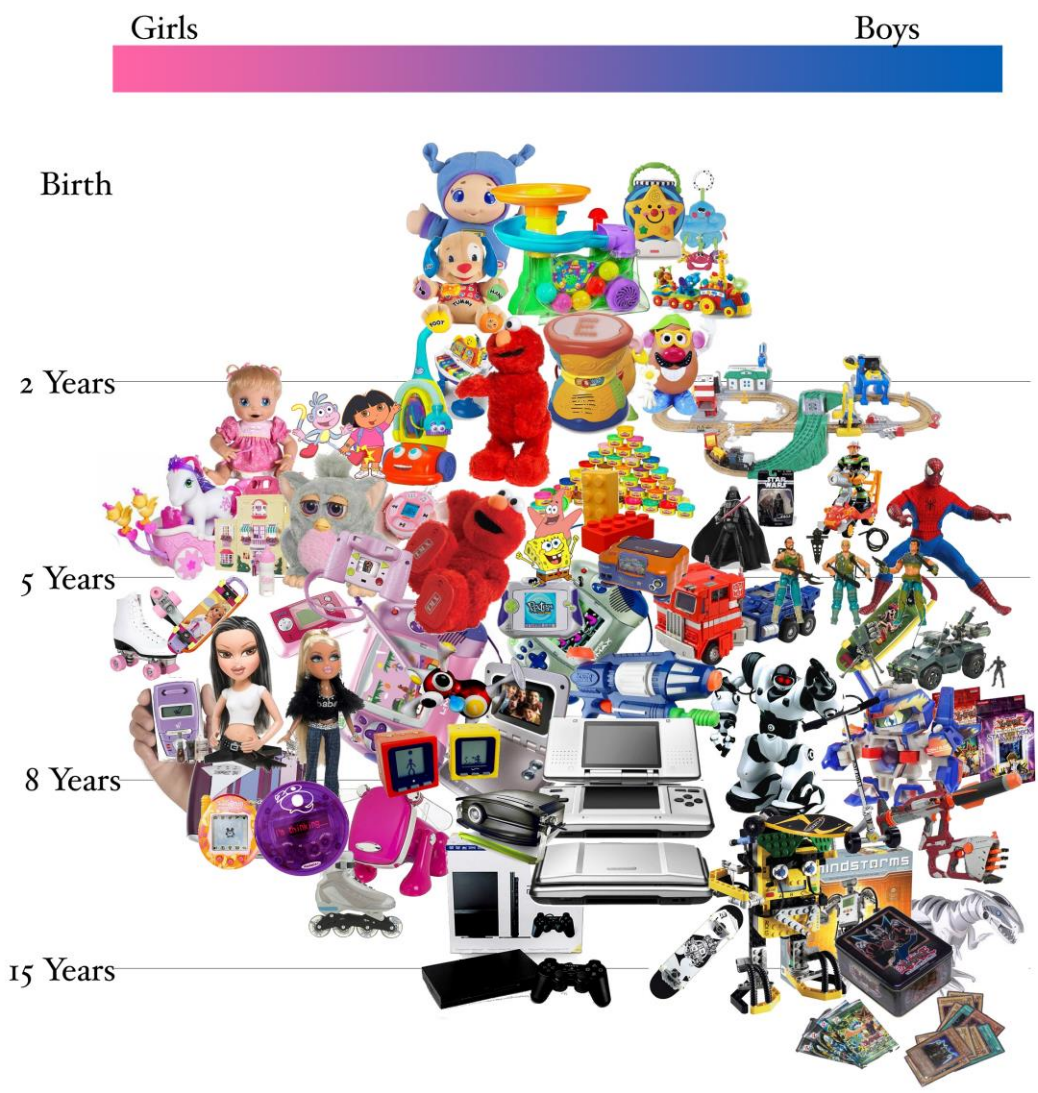


Figure 5.28. Popular toys grouped according to age and gender by Kudrowitz and Wallace (2010)

This scheme was used to extract a colour palette. In order to do this, the figure was pixelated by means of Adobe Photoshop, as shown in Figure 5.29.

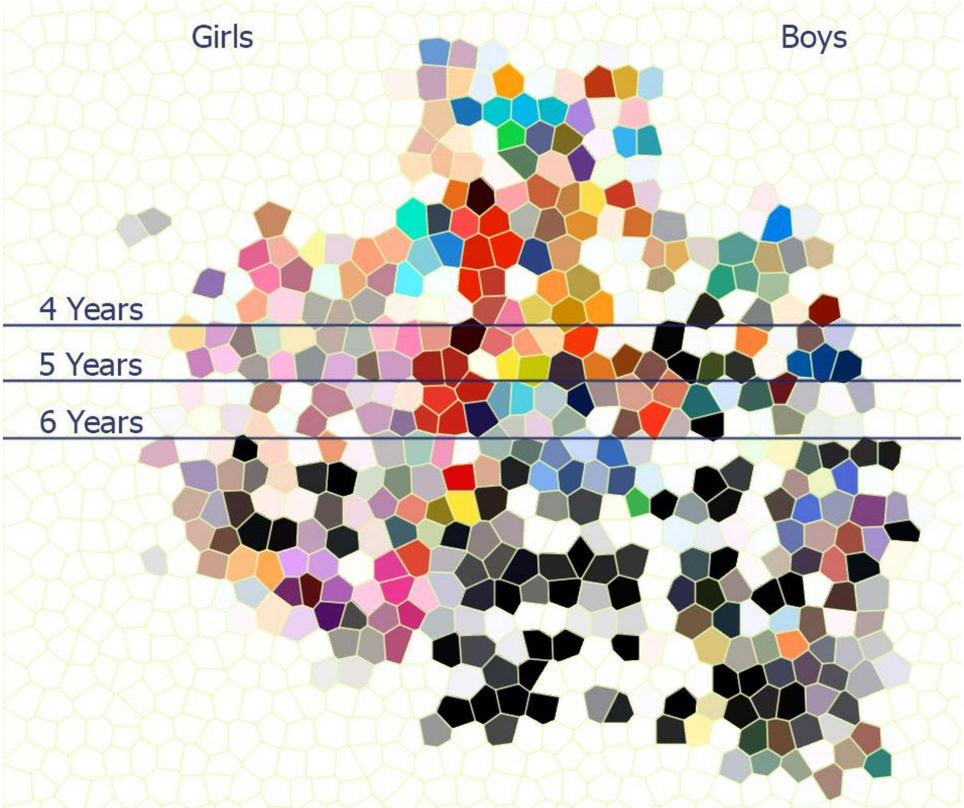


Figure 5.29. Pixelated scheme of toys

Then, in the age group from 4 to 6 years, the middle part was chosen as the colour palette of the toys suitable for both boys and girls and with no gender affiliation (shown in Figure 5.30).

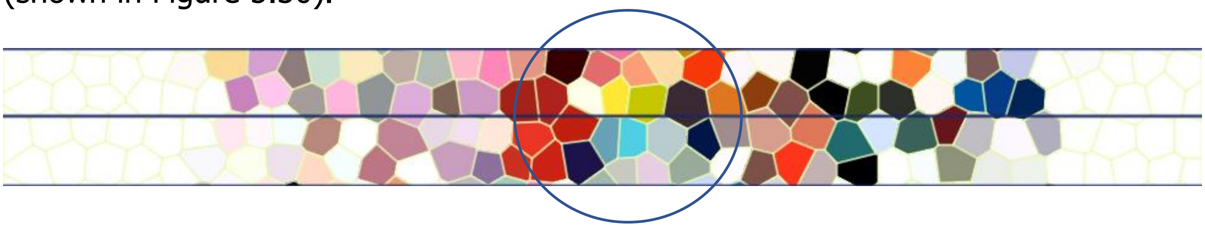


Figure 5.30. Pixelated scheme of toys for children from 4 to 6 years

Based on Figure 5.30, an example of the colour palette of toys with no gender affiliation for children from 4 to 6 years can be presented as the following:

Figure 5.31. An example of the colour palette of toys with no gender affiliation for children from 4 to 6 years

The colours were then grouped, with the more saturated colours in the top row and the less saturated in the bottom row. This colour palette corresponds well with the findings from the discussion of colour theories presented earlier, regarding how to communicate joy, positive surprise and happiness through colours. Based on the above, the colour palettes of the play equipment from the Undersea Friends play environment were the following:

Toy 1	 Dark blue was used only for small elements like eyes.
Toy 2	
Toy 3	This toy was mainly transparent, with a tinge of blue at the ends of the tentacles. The blue colour was chosen as it associated with water or the sea where these creatures live in real life. The reason for creating this toy as almost transparent lay in the use of coloured illumination which needed to shine through. The colours of the LED lights were red, pink, orange, yellow, green and blue, corresponding to the colour palette.

5.5.4.3 Expressing emotion through static posture and movement

Design products can initiate and influence movement. Body movements have a relationship with emotional states and emotional expression (Weerdesteijn *et al.*, 2005). Thus, physical expression can be used to elicit emotions. Based on Tan & Nareyek (2009) and Sauter *et al.* (2014), the description of the static posture and body movement which corresponds to three basic positive emotions is presented in

.

Table 5.1. Physical expressions which correspond to the basic positive emotions

Basic positive emotion	**Expressing emotion through static posture**	**Expressing emotion through movement**
Happiness	Open body posture, the spine is straightened with only a slight relaxation to it, the shoulders are pushed back to reveal an open body language, along with spread feet to show confidence.	Expression is open to the world, energy in movements, looks like dancing, arms spreading out in a sort of welcome of the world, the feet are placed to take a small skip, followed by an almost relaxed placing of the previously hovering foot on the ground.
Joy	Head backward, arms raised above shoulder and straight at the elbow, shoulders lifted.	Lateralised hand/arm movement, arms stretched out to the front.
Positive surprise	Head backward, chest backward, abdominal twist, arms raised with straight forearms.	High peak flexor and extensor elbow velocities, arms stretched out to the front.

The common features in the expression of positive emotions are an open body posture and alternation of energetic and almost relaxed movements. Although children with cerebral palsy may not show such physical responses due to atypical posture, muscle tone etc., it is worth incorporating some of the physical expressions in the toy, so that the toy itself expresses positive emotions. To implement these in the toy without making the object human, it is worth giving the object some "live" features to enable children to perceive the toy as an emotional creature. An example of a toy that communicates positive emotions through static posture and movement is presented in Figure 5.32.

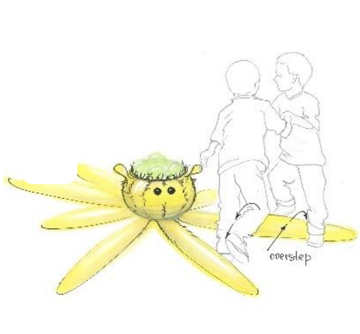
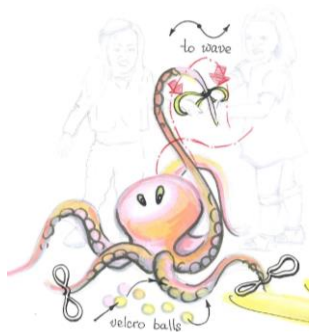
The body of this creature is open with a slight relaxation to it. Tentacles are spread out to suggest confidence. At the same time tentacles have a volume that suggest arms raised in joy or surprise. The movements appear as a result of direct contact by the child with the object. When a child presses on or pushes a tentacle, it reacts by returning to its original position, while colourful bubbles rise up in the main body of the toy.

Figure 5.32 - Communicating emotions through posture and movement

5.5.4.4 Object features and emotions

Chakrabarti & Gupta (2007) developed the Emotional Response Model that attempted to link object features with primary emotions through emotional features. What was new in their proposed model was the process of appraisal. A user sees object features that trigger perceptions of emotional features, while emotional features act as the vehicle for the primary emotions being evoked. According to Chakrabarti and Gupta (2007), object features, such as rounded, transparent and sharp, are the sensory features of an object. They can be objective as well as subjective in nature. Emotional features are the emotional qualities associated with an object, such as sporty, aggressive, enthusiastic and cute. These are based on object features, the socio-cultural background of the user and his or her personal preferences. Based on the Emotional Response Model, it is possible to find object features which correspond through emotional features to happiness, joy and positive surprise (see Table 5.2).

Table 5.2. Object features which correspond to basic positive emotions

	Happiness	**Joy**	**Positive surprise**
Emotional features	Liveliness Love Attraction Peace	Pleasure Cuteness Liveliness	Curiosity Liveliness Enthusiasm Unexpectedness
Object features	Balanced Organic Bright colours Soft Rounded Warm	Free form Light Simple Organic	Irregular Dynamic Bright colours Free form
Example of the design object			

5.5.5 Ergonomics of the Undersea Friends

An understanding of ergonomics principles is crucial to ensure that children can play with the play equipment designed for them (Goloborodko, 2012). It helps in creating play environments with minimum hazards, or without any at all, within the access zone. However, ergonomic considerations in designing toys are not only about the safety and comfort of the artefacts but also about ease of use, pleasure, functionality and contribution to development. A discussion regarding ergonomics in designing toys for children started in section 2.5.2. This section continues this discussion in more detail and in relation to the play environment created.

To increase the quality of play, the play environment should correspond to the anthropometric requirements of the children. Anthropometry data helps to evaluate the fit between the children as users and their play environment, including the toys they use. To implement these requirements practically, it was necessary to understand possible scenarios of play with the play equipment, necessary actions to create these scenarios, and children's abilities.

The size of the toys had to be commensurate with the child's anthropometry, bearing in mind that they were intended for use by more than one child. The ergonomic children models in proportion to the toys (presented schematically) are shown on the ergonomic diagrams (see Figure 5.33 - Figure 5.36). Female ergonomic model of the 5th percentile[1] of a child 4 years old (full body is 96,5cm) and male ergonomic model of the 95th percentile of a child 6 years old (full body is 127cm) were taken to cover the anthropometric data of the target group of children, which is aged from 4 to 6 years. The ergonomic diagrams also show possible actions of children when playing with the toys.

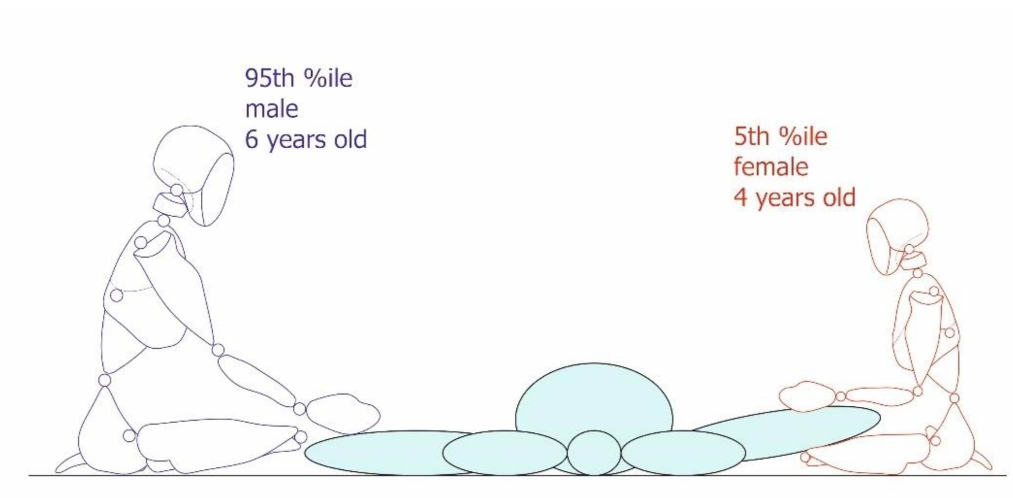


Figure 5.33. Ergonomic diagram for toy 1 positioned on the floor

1 [1] Percentile in ergonomics means the percentage of people at each anthropometry measure, like height, weight, etc. More often, designs are specified to fit from 5th percentile to 95th.

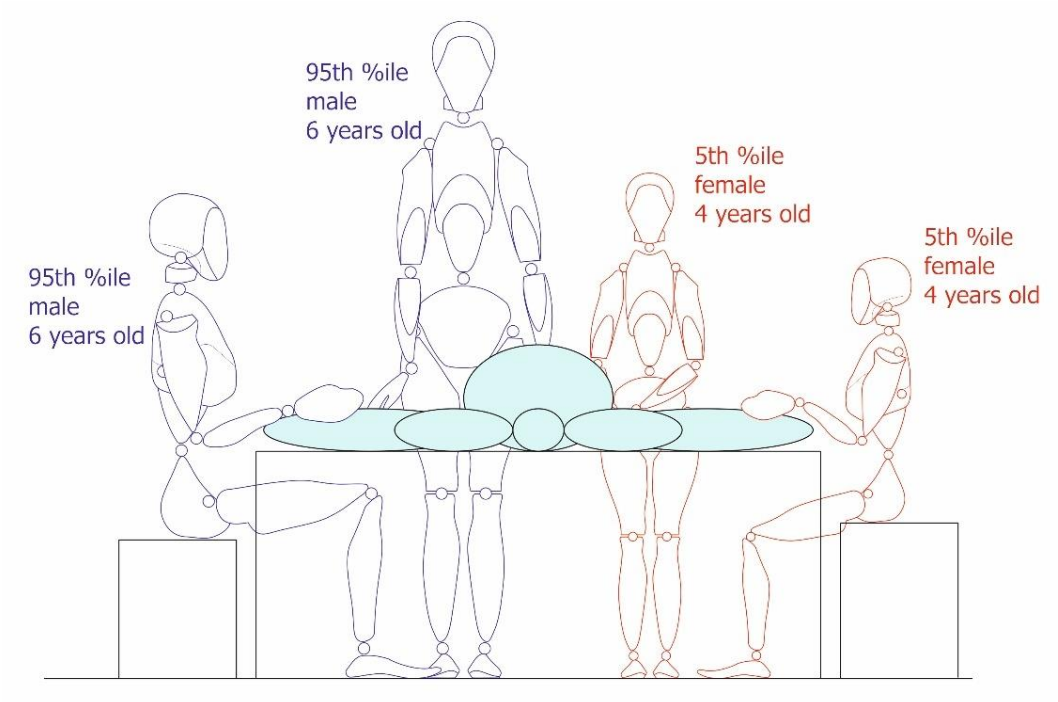


Figure 5.34. Ergonomic diagram for toy 1 positioned on the table

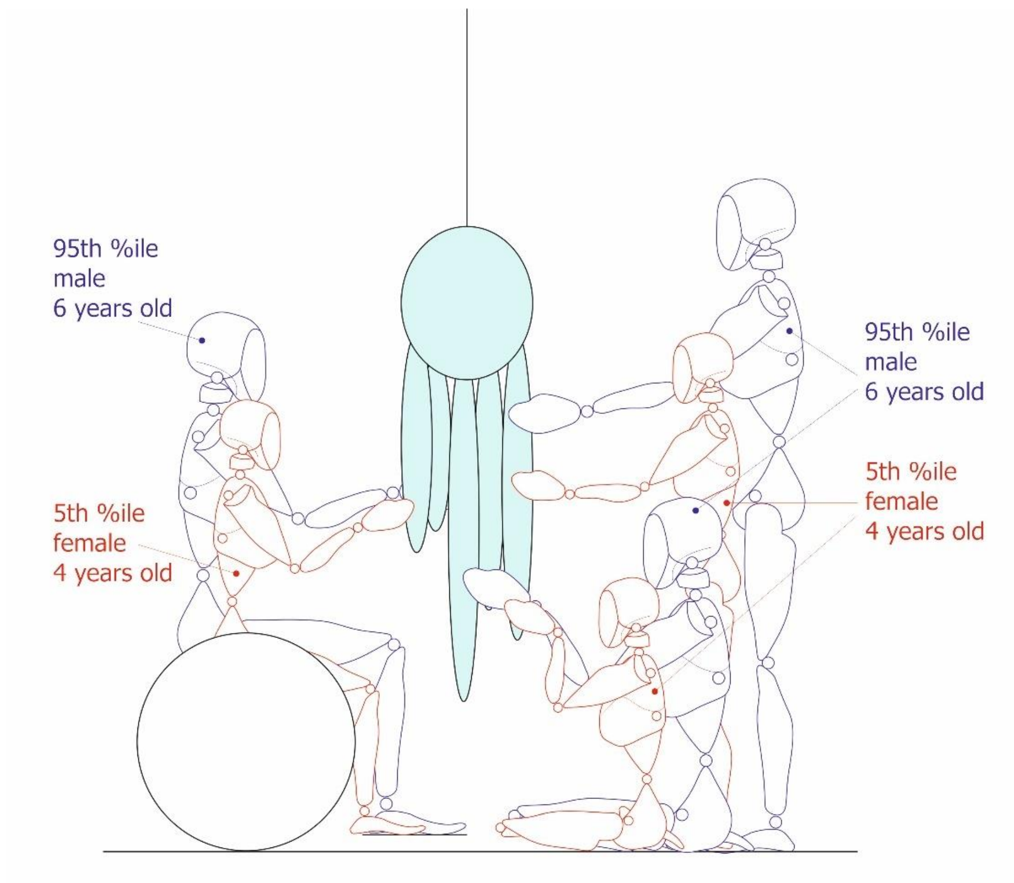


Figure 5.35. Ergonomic diagram for toy 2 which hangs

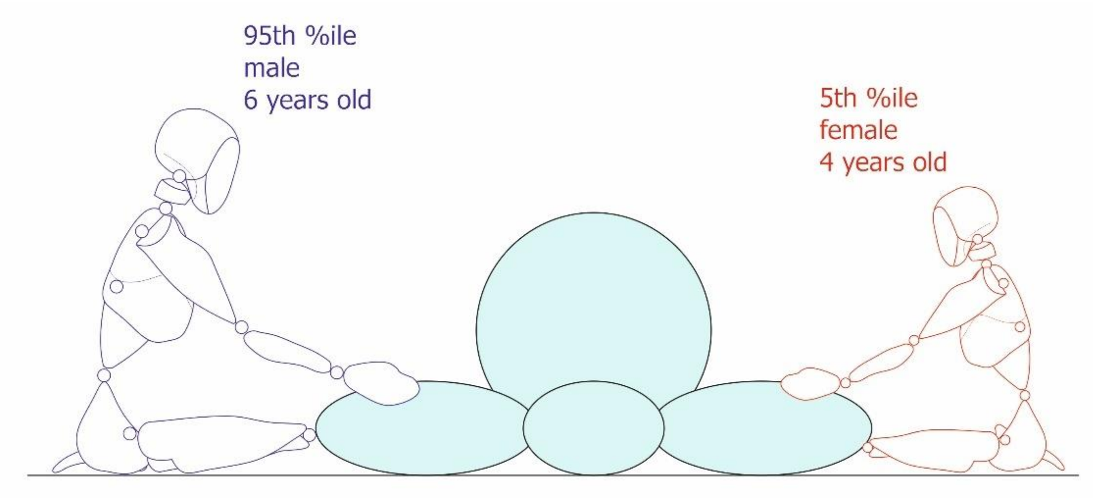


Figure 5.36. Ergonomic diagram for toy 3 positioned on the floor

The play equipment supposed full as well as for partial body involvement. Play activities with the toys could be performed equally well using hands, legs, fingers or elbows, as the toys needed to be responsive to the diverse physical ways by which the children may engage. The necessary effort for activating and playing with the play equipment, for example pressing buttons, pushing, squeezing or pulling tentacles, needed to be minimal to make it inclusive for children with different manifestations of cerebral palsy and different levels of physical development.

It was also important to avoid using small detachable elements in the toys, so as to be sure that a child could not put them in her or his mouth. Therefore, the smallest detachable element on the toys had to be bigger than the maximum opening of a child's mouth. This measurement for six-year-old children is 52 mm for both boys and girls. Thus, the size of the smallest element had to be at least 53 mm.

It was important that lights did not come on or go off suddenly during illumination, because for children with visual difficulties it could be challenging to follow them and as a consequence to participate in play. Colours of the illumination, as a way of transferring information, had to be included carefully, because too many could have had a "Christmas-tree" effect, when it would be difficult to work out which information was important or primary and which was not (Lueder & Rice, 2008). Therefore, when a toy required a certain action to activate it, it had to illuminate one colour which changed with each consequent action. A multicolour illumination took place only during reward (group) feedback from the toy, when there was no need for any further action and children could enjoy the colours and relax.

The functionality of the play equipment, its safety and technological aspects are considered in detail in the next sections.

5.5.6 Practising social skills through the Undersea Friends

Interaction with peers during play is the main component of the social competence of young children and includes a number of social skills. The main skills were defined in section 2.3.1 and are presented in Figure 5.37.

Figure 5.37. Social skills for young children

The design object's main function - development of social competence through practising social skills - is represented in particular by three of the skills in this Figure: cooperating, taking turns and sharing. In reality, most of the social skills are inter-connected and depend on each other. Therefore, when a toy was intended for practising cooperation, for example, it meant that "cooperating" was a dominant skill but not the only one which could be practised with it.

Finally, a play space was designed, consisting of three toys which corresponded to these three social skills. These toys were: "Octopush Olly", for practising turn-taking; "Hexapush Hetty", for practising cooperation; and "Larry Long Legs" for sharing. All these toys had their own personality and lived in a playful, undersea environment. This space could be entered from different points and explored freely.

5.5.7 The Octopush 'Olly'

Taking turns means that children do something one after the other, rather than at the same time. It is not an innate social skill but one of the most critical which children need to develop (DeLuzio & Girolametto, 2011). While it can be frustrating for a child to wait for something that she or he really wants, taking turns is significant in the development and maintenance of effective communication, friendship with others and active participation in play activities.

The Octopush was designed with this social skill in mind (see Figure 5.38). It has eight coloured tentacles - red, yellow, blue and orange. Inside each tentacle is a LED strip. At the end of each tentacle there are coloured circles which show areas with a button placed underneath. When the toy is turned on, the end of one tentacle lights up (on the area with a circle). This attracts attention and signals two possible scenarios of actions: the first is to touch the tentacle with the light and the second is to press on any tentacle without a light.

If a child presses on the tentacle with the light, the LEDs on the strip start to light up one by one, starting from the end of the tentacle and moving in this way through the body to the end of a randomly chosen next tentacle. The whole moment of the light moving along the tentacle is accompanied by a sound that seems like falling drops of water. The immediacy of the feedback demonstrates clearly the cause-and-effect of the toy, which in this case is determined by the individual child's actions.

The second scenario starts if a child presses on an inactive tentacle. In this case, light starts running along that tentacle, but before coming to the body of the toy, it runs back. The accompanied sound is short and similar to a bursting water-bubble. As soon as the light 'arrives' at the next tentacle, again two scenarios are available.

The idea of this toy is to practise turn-taking skills, so children practically should work out that they can 'follow' the light. After four consecutive presses on the active tentacles, children get a reward feedback (group feedback), when the whole toy lights up and the Octopush sings a song about itself. This reward song consists of two parts which are swapped each reward time. The lights change colour, from yellow to green, then to red, blue and finally white.

Figure 5.38. The Octopush 'Olly'

Although the main function of the Octopush is practising turn-taking, in reality – as stated earlier - playing with it allows multiple skills to be developed simultaneously. These include:

- Social skills, such as sharing, cooperation, joint attention, visual/sign/speech contact,
- Physical skills, such as fine and gross motor movements, coordination,
- Sensory skills such as tactile, visual and audio,
- Emotional skills, such as understanding positive emotions,
- Cognitive skills, such as knowing colours, counting, understanding consecutive and cause-and-effect actions.

5.5.8 The Hexapush 'Hetty'

The skill of cooperation is important in children's daily lives, as everyday actions often require successful collaboration with peers. Peer cooperation is conceptualised as coordinated interaction between peers to reach a common goal (Olson & Spelke, 2008). According to Endedijk *et al.* (2015), shared cooperative activities have three main features: participants are mutually responsive to each other; they have a shared goal; and they support each other in their roles to achieve the shared goal. To this end, the second toy was designed – Hetty the Hexapush (presented in Figure 5.39), the focus being to practise cooperation and interaction with peers.

Hetty consists of the main body, the base and six tentacles. The base component is designed to hold all the electronics and technical elements, also for the stability of other components, such as the body and six tentacles. The body itself is an acrylic sphere, with the eyes attached to the inner top. These eyes are two transparent spheres filled with water, with the eyes' pupils floating freely inside. This creates an effect that the Hexapush is looking at all the children who are grouped around. The spherical body is sealed and has a small amount of distilled water in it. At the bottom of the sphere are attached components of six water fountains and LED lights which correspond to the tentacles.

The six tentacles are elastic, semi-transparent objects with a sensory surface that imitates suckers. Inside each tentacle is a specially designed button and LED strip.

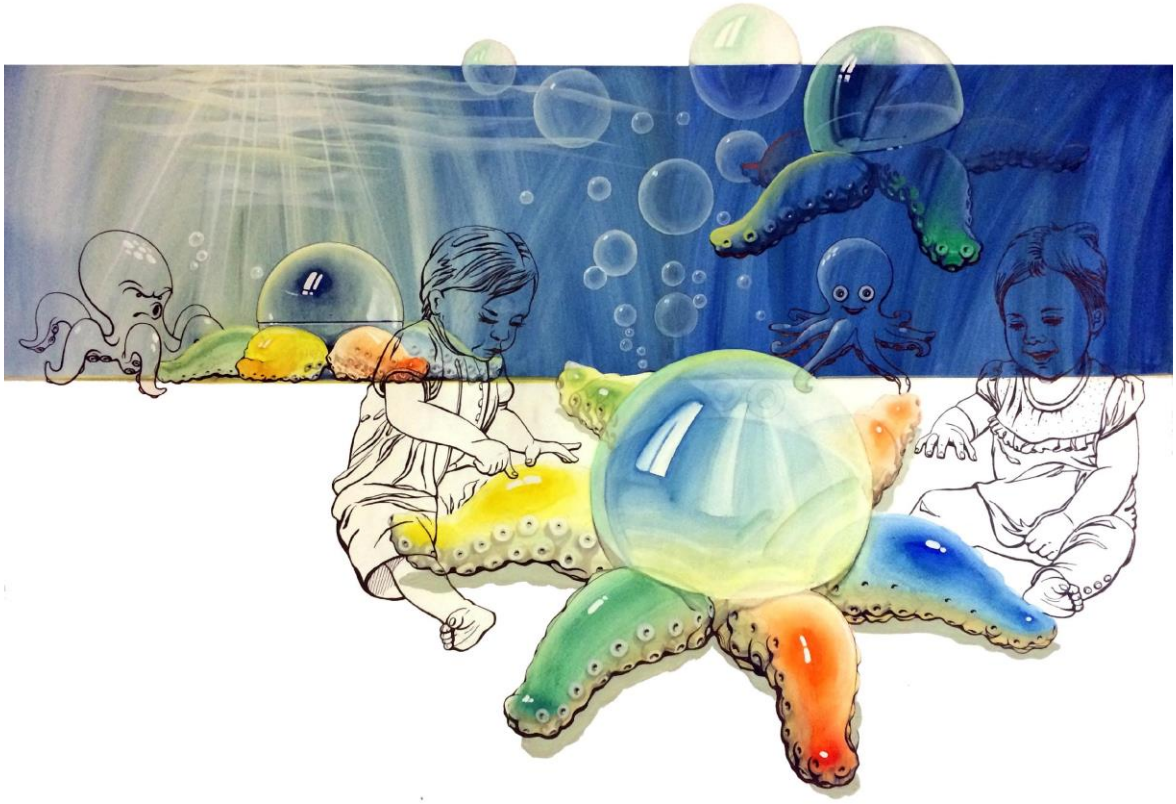


Figure 5.39. The Hexapush 'Hetty'

The idea of the toy is that when a child presses on or pushes a tentacle (any part of it), it reacts by lighting the LED strip inside and producing a short sound. It also activates the water fountain that corresponds to the active tentacle and LED lights under the fountain. The feedback is activated immediately after a child presses on the tentacle and the tentacle itself returns back to the initial position. After each interaction with the tentacle, the colour of its LED strip is changed and the sound is repeated.

One child may normally reach one tentacle, when sitting with Hetty. Therefore, when a child plays with the toy, there is an individual feedback, with one tentacle lighting up and one water fountain activated. The more children participating in play, the richer feedback they get - thus, children should intuitively work out that they can cooperate and play together to activate more illumination and more fountains.

The reward (group) feedback is produced when four or more tentacles are activated within a five-second period, indicating group play and cooperation. This consists of the following:

- The whole toy is lit up, with the lights changing their colours from red to pink to yellow to green to blue and to white,
- All the fountains run with water and are illuminated,
- Hetty sings a song about itself.

As with the Octopush, the Hexapush's main function – that of practising cooperation – in reality also allows development of multiple skills, among which are:

- Social skills, such as sharing, joint attention, visual/sign/speech contact,
- Physical skills, such as fine and gross motor movements,
- Sensory skills such as tactile, visual and audio,
- Emotional skills, such as understanding positive emotions,
- Cognitive skills, such as knowing colours, counting, understanding consecutive and cause-and-effect actions, language and communication.

5.5.9 Larry Long legs

Sharing is a vital life skill that children need to learn so they can make and keep friends and play in a group (Brownell *et al.*, 2012). Learning to share can be a challenge, but when a child succeeds, he or she feels more confident to play with peers. It gives a child better understanding of feelings of others and the ability to negotiate difficult situations more independently.

The idea of Larry Long Legs was to practise social skill – sharing. The toy is visually reminiscent of a jellyfish, with its soft body and tentacles. It has an even number of tentacles, and each pair is one piece with two ends. Each piece of the toy is made from a different fabric with its own texture and colour. The schematic view of the toy is presented in Figure 5.40.

Figure 5.40. Larry Long Legs

When a child pulls one end of a tentacle, it becomes longer and the tentacle with which it is paired (the second end of the piece) consequently becomes shorter. The bottom parts of the tentacles have slightly bigger diameters than the central parts, so it is impossible to pull out a whole tentacle from the body.

The idea of this toy is to try to make the lengths of a pair of tentacles approximately equal. If this is achieved, the whole tentacle (two ends) lights up as a reward. When all tentacles are of similar length, the children get a group feedback with illumination of the body and of the tentacles, and Larry Long Legs sings a song. All the tentacles also have small bells to make the playing process more engaging and interactive.

The toys described above formed the play environment, Undersea Friends, connected by a common theme. The Octopush and the Hexapush were implemented. The next section discusses the process of building their prototypes. Larry Long Legs was not developed as a prototype because of time constraints.

5.6 Creating the prototypes

Implementation of the prototypes involved the creation and testing of the toys, refinements in their concept and technical parameters, setting them up at the National Institute of Conductive Education, and final minor technical adjustments.

The programming part of both prototypes was realised in cooperation with Dmitriy Balinskyi, an IT specialist from "Fulcrum Software" company. Therefore, the programming is not regarded as part of this study.

5.6.1 Hexapush Hetty

This section presents the process of building the prototype of Hexapush Hetty. It gives the rationale for taking certain decisions, shows challenges faced during the prototyping and ways in which they were addressed.

As mentioned earlier, the recognisable shape of an octopus inspired the idea of this toy. It was important to build the prototype as close as possible to the designed concept. Therefore, a 3D model of the toy was first of all created in the Autodesk 3D Max package. Figure 5.41 shows this model.

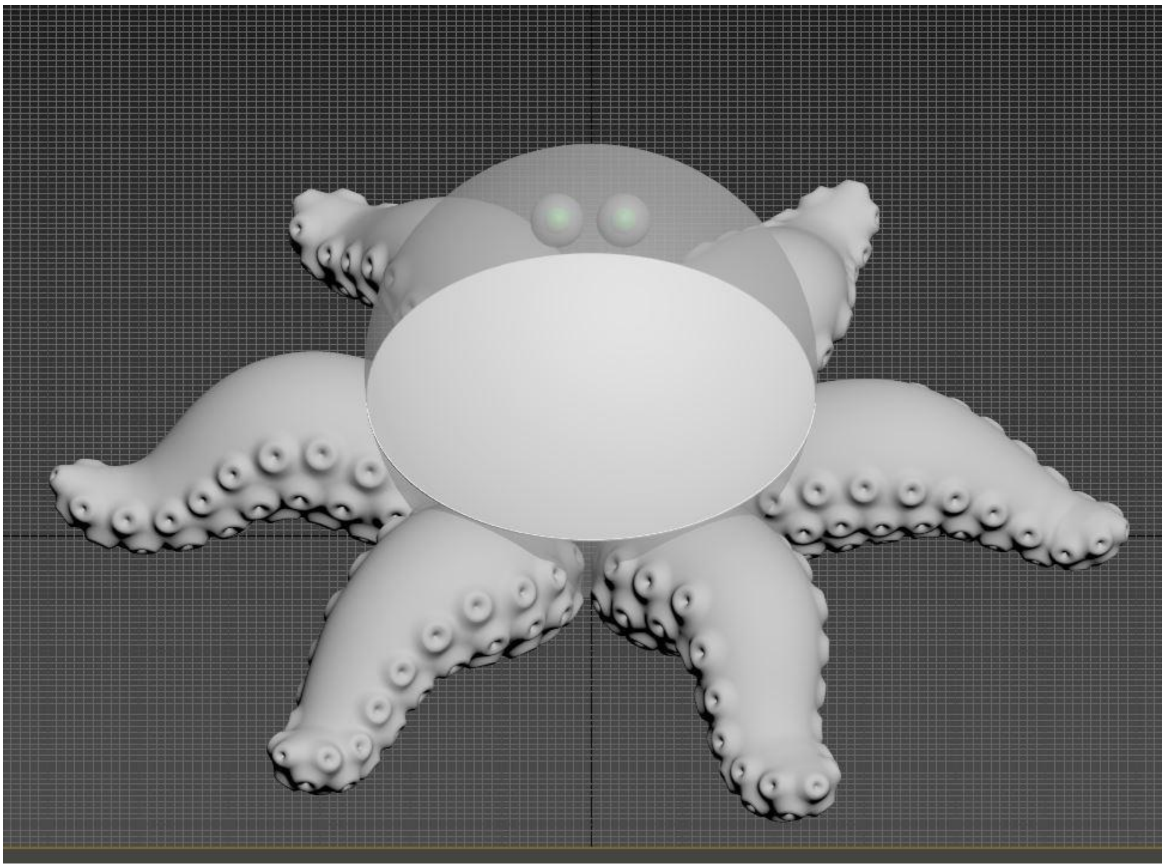


Figure 5.41. 3D model of Hetty

All tentacles have their own form and sensory surface, with suckers on their bottom part. In practice, creating elastic transparent tentacles with such an intricate form was a complex task. Two approaches were considered for making these. One was to use silicon or thermoplastic elastomer (TPE) to mould their shape. They had to be hollow in order to make it possible to place LED strip and buttons inside, as well as to make it lightweight and elastic. Considering the thickness and the volume of the tentacles, there was however a concern about how they would keep their shape. The other approach was to use 3D printing technology. The popular materials for 3D printing are Acrylonitrile butadiene styrene (ABS), which is a thermoplastic material, and polylactide acid (PLA), which is a biodegradable and bioactive thermoplastic. Figure 5.42 presents a first scaled version of Hetty (with a slightly different shape of tentacles in comparison to the final version), made using ABS filament with a Zortrax M200 3D printer.

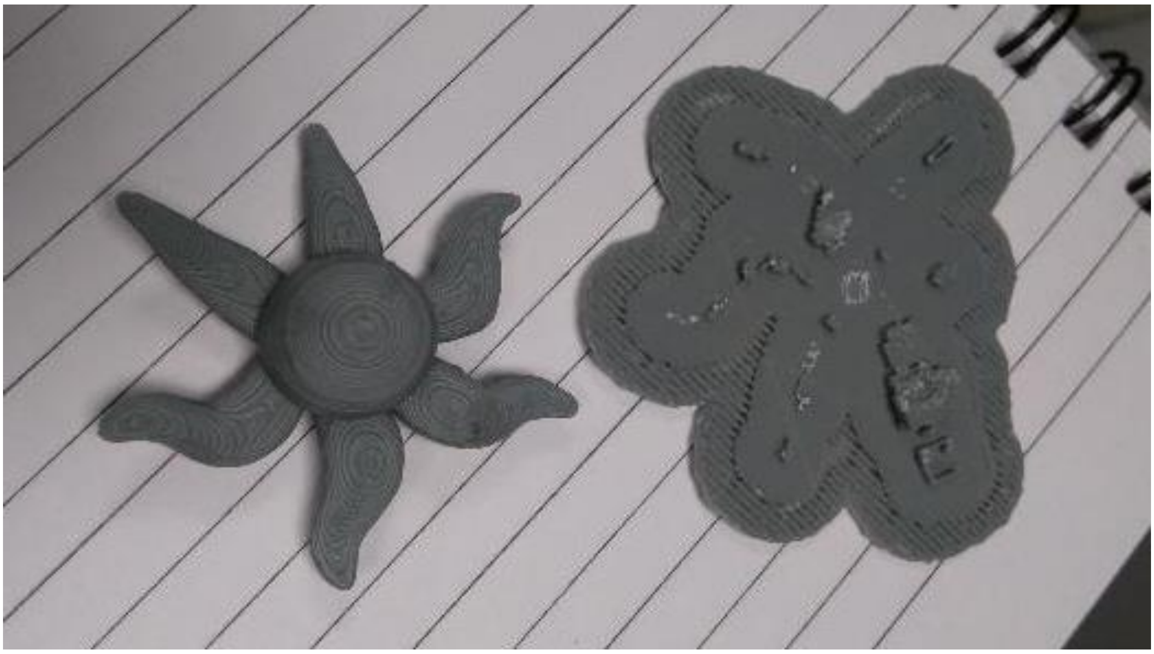


Figure 5.42. First scaled version of Hetty

However, there are also some Thermoplastic polyurethane (TPU) and TPE filaments, which were suitable for the 3D printing of the tentacles. Material properties of these materials meet the requirements for the design and are safe to be used by children. Transparent filament made from TPU and TPE are available commercially.

Considering the material properties, the effectiveness of 3D printing and the cost and availability of filaments on the market, it was ultimately decided to use TPU material for 3D printing. The main reason for avoiding use of TPE was that the transparent version of this material was not available on the market as a ready filament.

It was noticed that nozzle temperature and speed of printing had a high impact on the transparency and the quality of the printed parts. Nozzle temperature also had a strong impact on flexibility. Figure 5.43 presents two variants of tentacles, printed with the same TPU filament at 215 (variant a) and 245 (variant b) degrees. It is also worth noting that using a high temperature for 3D printing made it difficult to take the raft off the printed part. More than ten sample printings were performed in order to find the best temperature printing speed and other settings for the right and stable printing quality.

Variant a (printed at 215 degrees)

Variant b (printed at 245 degrees)

Figure 5.43. Two variants of tentacles printed at different temperatures

Several different 3D printers were used to test printing of the tentacles with TPU filament. A combination of quality and printing speed led to the decision to use Makerbot Replicator. However, the extruder of the 3D printer was redesigned by Dr. Hatef Dinparasti Saleh at Heriot Watt University, Edinburgh, to make a 3D printing process with soft filament smooth. Considering the built volume of the replicator, 28.5L X 15.3 W X 15.5 H cm, and with respect to the tentacles' dimensions of 46 cm in length and 20 cm in maximum diameter, it was decided to print the tentacles in six parts. Figure 5.44 shows tentacle 1 before assembly. Printing each part lasted between 8 and 12 hours, so printing tentacles took nearly 360 hours in total. This time did not include the printer calibrations and other system preparations.

Figure 5.44. Tentacle before assembly

Printing each tentacle in six parts also added significant difficulties for assembly but had an advantage in that LED strips and push buttons could be placed inside. Figure 5.45 shows tentacle 1 before attaching the last part. Tentacles were first assembled up to this point and then LED strip and push buttons were inserted.

Figure 5.45. Tentacle before attaching the last part

Cutting orientation was done differently for different parts of the tentacle, in order to study its influence on assembly. In order to assemble them, a 3D printing pen was used (see Figure 5.46).

Figure 5.46. Assembling tentacles with 3D printing pen

3D printing technology was also employed to print off the base of the prototype (see Figure 5.47). In view of the built volume of the 3D printer, the 3D model of the base was divided equally into four parts, using the Netfabb software from Autodesk. Each part was printed separately and then assembled with the same manual 3D printing pen.

Figure 5.47. 3D base of the prototype

Hetty's base was designed to allow placement of two power banks, each 20000 mAh, and the electronics. ABS filament was used for the printing of the base. The base part was custom-designed in 3D Max to fit each tentacle's shape where the tentacle joined the body. This made it possible to have just one correct tentacle for each hole, which simplified the assembly process. For further safety, sticky fabric tape in each hole was used to keep them attached to the base after assembly and prevent misconnection of the push button wires or LED strip connections.

As was mentioned earlier, it was critically important to make the switching system sensitive enough to work uniformly along each tentacle. This would mean pushing anywhere on the tentacle would activate the electronics. In order to achieve this, different methods, such as pressure sensors, conductive fabric and push buttons, were considered. However, with simplicity, reliability and cost in mind, it was decided to make special push buttons, four in each tentacle. Aluminium foil, placed on their bottom inner side and springs attached to their top inner side, acted as switch buttons. All springs were connected to each other. The distance between the spring end and the aluminium foil determined the sensitivity of the push buttons. Having four interconnected springs along a tentacle provided smooth and reliable uniform sensitivity for activation.

The central part of Hetty is a spherical shape with a diameter of 50 cm, made from acrylic sheet using a hot-air forming method. The thickness of the shell changes from 4 mm to 1.5 mm in some places, which during manufacture makes it delicate to cut the bottom part and cut the circular shape to fit it on top of the base and tentacles. However, it is important to note that being relatively thin in some areas does not affect its safety. Cutting of the sphere was performed manually. Figure 5.48 shows the six flower patterns after this cutting.

Figure 5.48. Cutting the sphere

Acrylic sheet was used to close the bottom part of the sphere and make a space for water fountains. Then this acrylic sheet was glued to the bottom part of the sphere and sealed with silicon sealant to make it waterproof. A laser cutter was used to cut the acrylic sheet and make holes for the water fountains and rings surrounding them (see Figure 5.49).

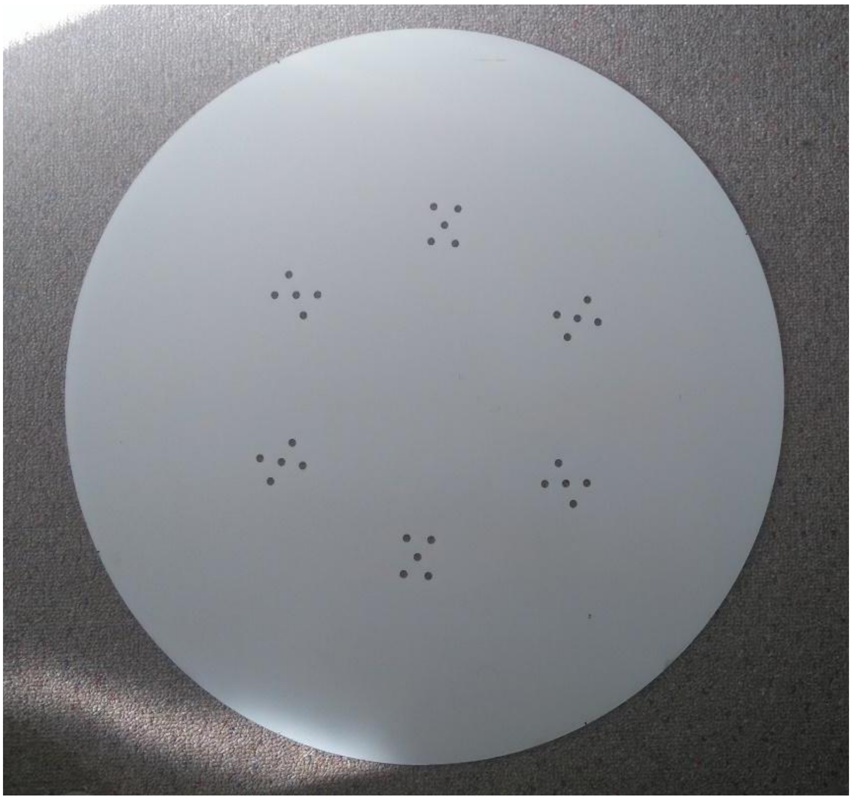


Figure 5.49. Acrylic sheet to close the sphere

150 LEDs from a 5-metre addressable LED strip was placed in the tentacles and the main body. A silicon protection layer at the top made the LED strip waterproof and prevented misconnection due to bending.

Six DC motors were attached to the acrylic sheet to run water fountains in the sphere. The system with these DC motors was taken from ready water-fountain speakers available on the market. Figure 5.50 shows a DC motor and spiral vessel for the fountain speaker.

Figure 5.50. DC motor and spiral vessel for fountain speaker

One of the important issues during prototyping was choosing the liquid for the fountains. The popular liquid which is usually used in fountain speakers is “Artware Oil C-300”. This oil is not available on the market, so different alternatives were tested, such as mineral oil, baby oil and ethanol. Eventually, with safety and performance in mind, it was decided to use distilled water. Ethanol and oils were not used because of concern about chemical reaction with the glue used between the acrylic sheet and the sphere. Figure 5.51 shows the assembled water fountain and accessories on the acrylic sheet.

Figure 5.51. Assembled water fountains and accessories on the acrylic sheet

The acrylic sheet was then glued to the bottom part of the sphere and fully sealed with the silicon sealant to make it waterproof (presented in Figure 5.52).

Figure 5.52. Sealed sphere

The DC motors and addressable LED strips in the tentacles and on the body part of Hetty could be activated by the push buttons in the tentacles.

To control the circuit, a Raspberry Pi 3B was placed in the heart of Hetty. Prior to using the Raspberry Pi, the feasibility of using an Arduino was studied. Because LED strip and audio were supposed to work simultaneously, and both LED strip and audio output needed to be controlled by a high-frequency, pulsed width modulation pinout, using the Arduino raised technical difficulties. Notwithstanding, Raspberry Pi is a powerful miniaturised computer that has quite high power consumption and has a number of advantages, such as Python 3 compatibility, HDMI output, onboard Wi-Fi and Bluetooth, all of which made it a suitable for the prototype. A VNC viewer was used to have live control of the software and make live modifications during testing. The software for the Raspberry Pi was developed in a Python 3 environment.

Figure 5.53 presents the assembled DC motors connected to the water fountain vessels and to the Raspberry Pi.

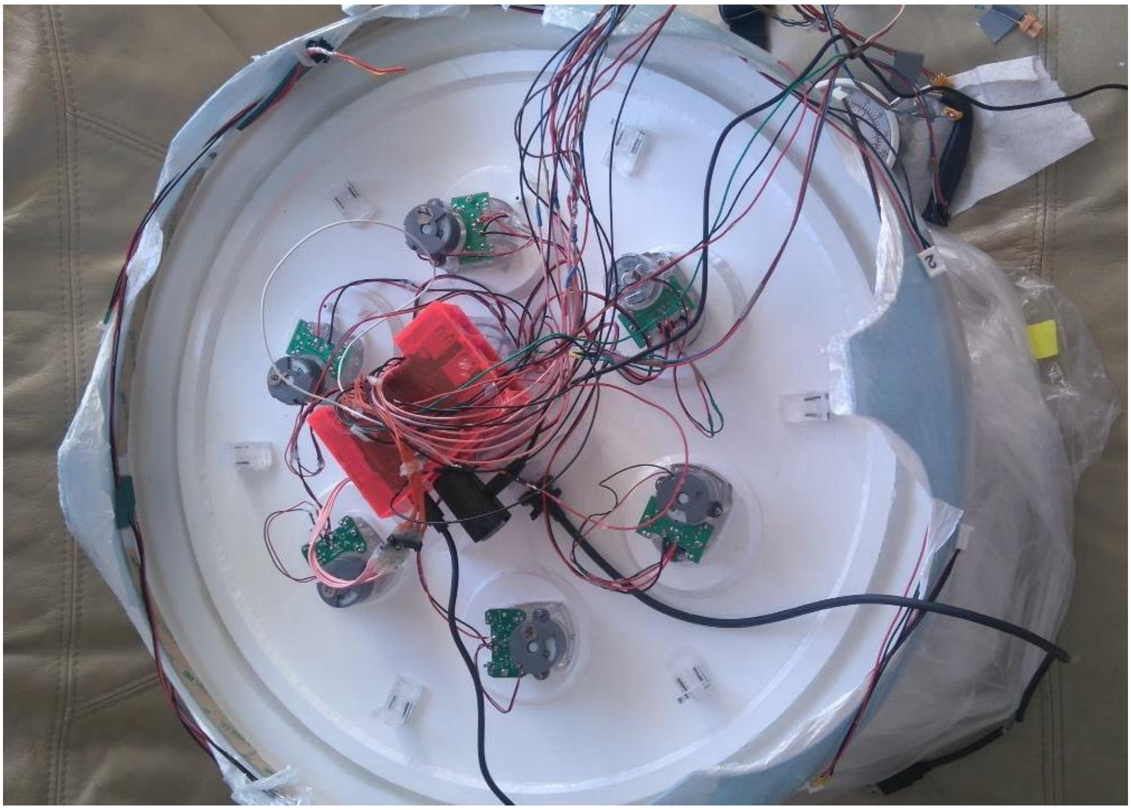


Figure 5.53. Assembly of the electronic part of the sphere

The final version of Hetty’s prototype is presented in Figure 5.54.

Figure 5.54. Hexapush Hetty

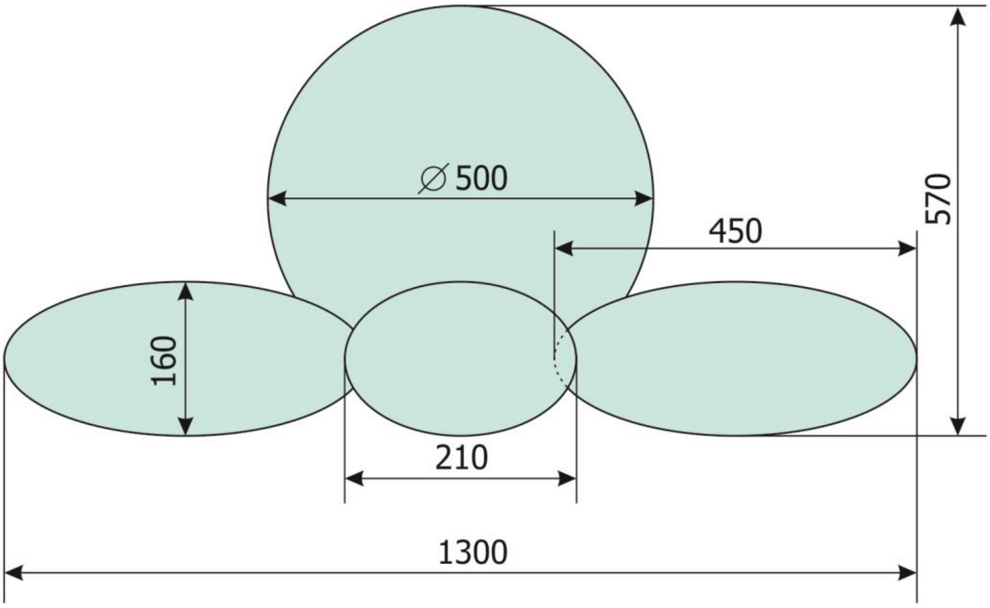


Figure 5.55. Dimensions of the final prototype (Hetty presented schematically)

5.6.2 Octopush Olly

This section describes the process of making the prototype of Octopush Olly and provides a basis for each step during this process.

The central part of Olly. is a hemispherical shape, which acts as its body. This has to hold two 20000 mAh power banks, a Raspberry Pi 3B and an electronic circuit. It was printed on the 3D printer in six parts, using ABS material. Four parts formed the bottom part of the hemisphere and the fifth and sixth parts were the cover part at the top, providing the access to inside of the shape (see Figure 5.56). The first attempt was to use super glue to connect the four parts for the bottom part. However, it was noticed that super glue did not provide the necessary durability of connection. Therefore, it was decided to use the 3D Pen with the same ABS material to connect these four parts to each other. This provided a reliable and durable connection and in this way, separate printed parts became a holistic body and its cover.

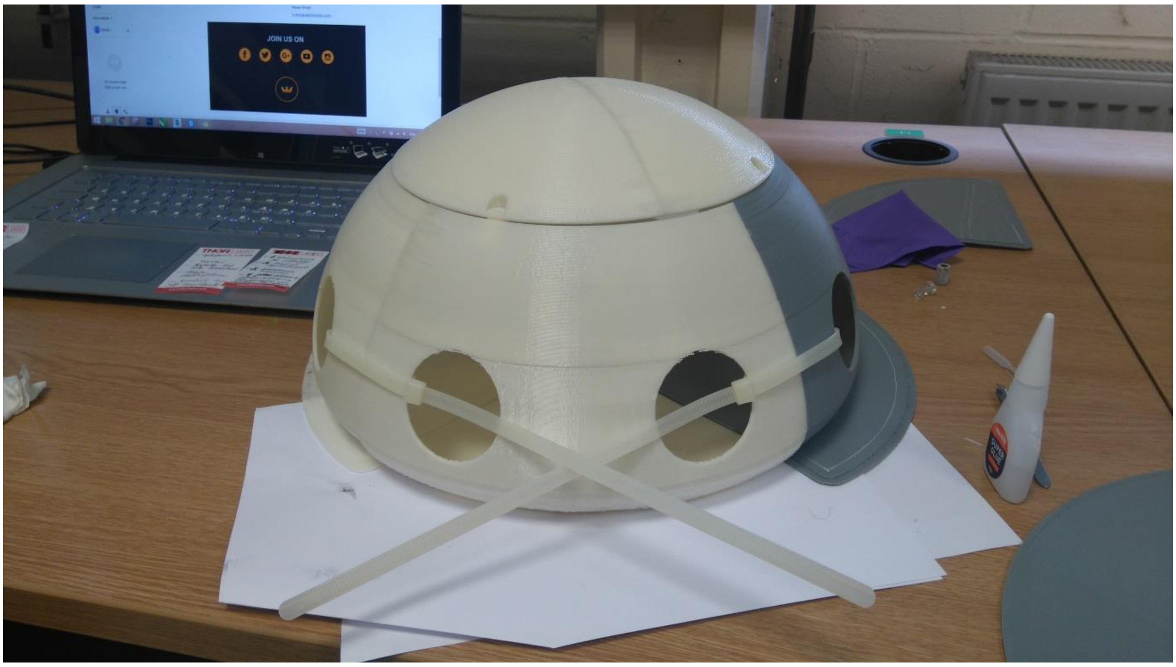
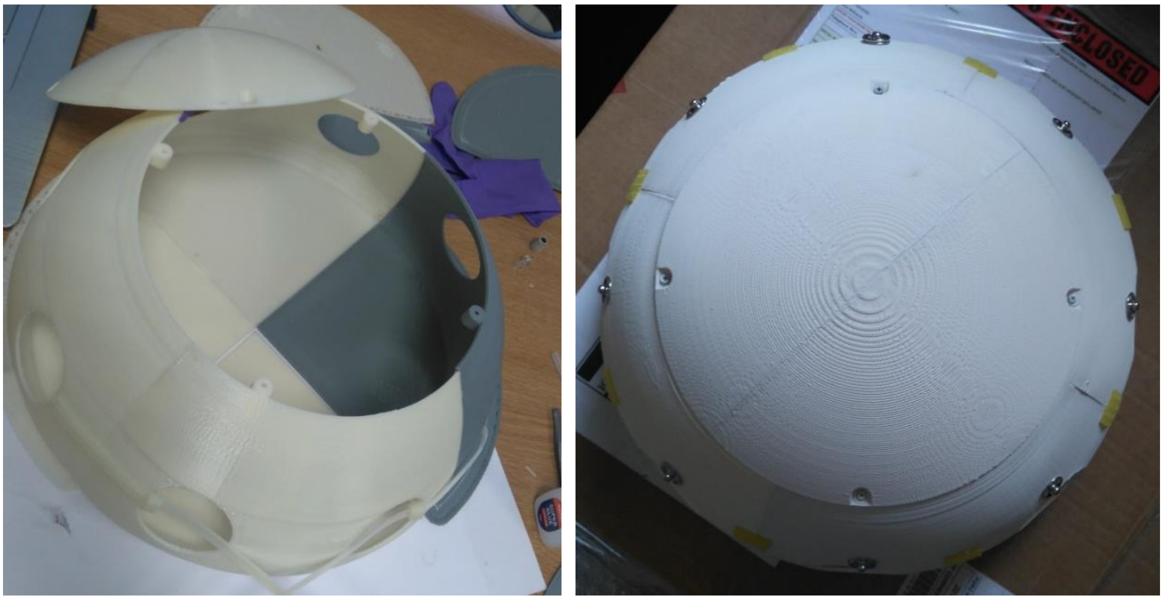


Figure 5.56. Hemispherical body for Octopush Olly

As can be seen in Figure 5.57a, there were four pilot holes, one for each part of the body and designed to provide an easy fix for the cover. In order to fix the cover on the top of the body, four M2.5 self-tapping screws were used (shown in Figure 5.57 b).



a) b)

Figure 5.57. Fixing the cover to the body

The length of each tentacle was nearly 45 cm. PU Flexible Ducting Hose with a diameter of 50 mm was used as the tentacle body structure. The holes on the hemispherical body had a diameter of 46 mm, which made it easy to screw the helical structure of the ducting house onto it. Then for extra safety it was glued using a hot glue gun (see Figure 5.58).

Figure 5.58. Connecting tentacles to the body

The other end of each tentacle was covered with a 3D-printed cap to provide a smooth shape (see Figure 5.59).

Figure 5.59. 3D printed caps for the tentacles

Eight sensory buttons were taken from a recycled toy and used in each tentacle as a switch. The connecting wire from the push buttons to the Raspberry Pi pins were placed inside the tentacles. These buttons were also integrated with old recycled keyboard pushing buttons (see Figure 5.60). Eight pushing keys from a keyboard were cut to place on the pushing sensors. This method provided a reliable and smooth switching mechanism.

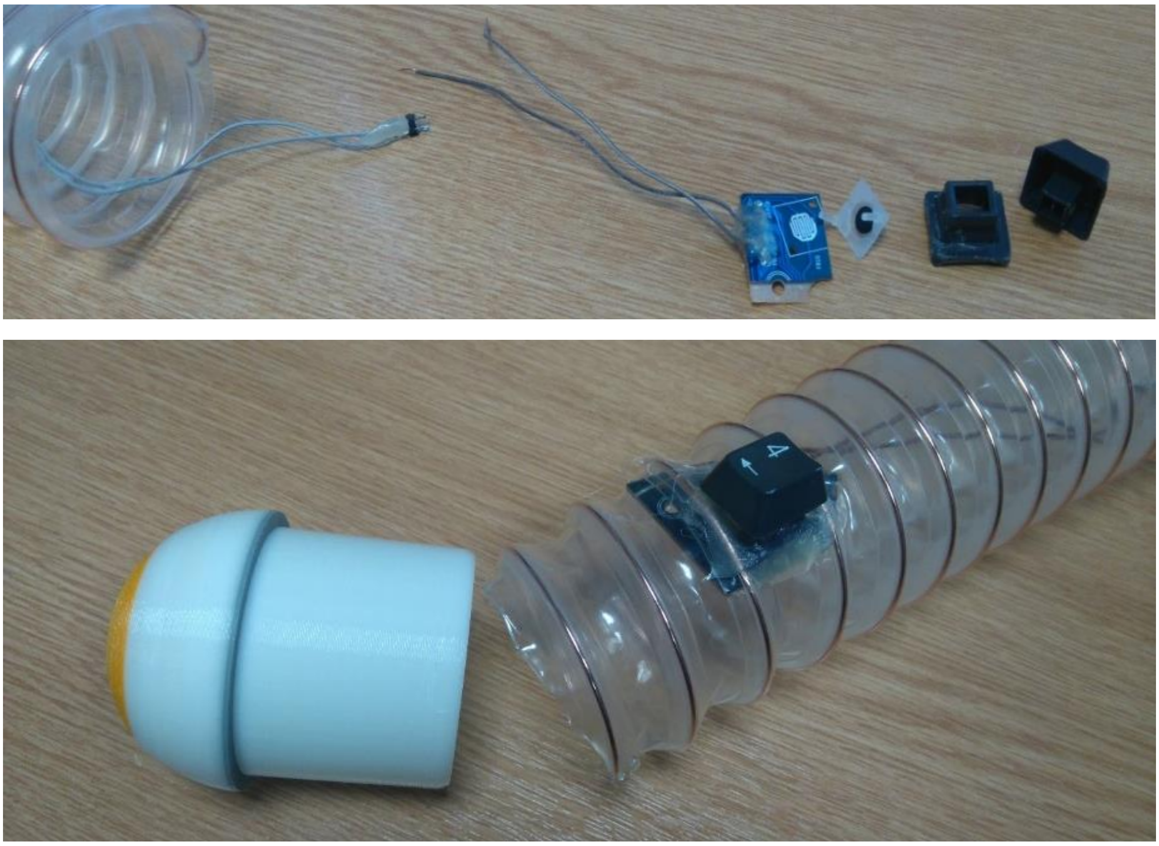


Figure 5.60. Specially designed buttons for Olly

In same way as explained in the previous section, Raspberry Pi activates the LED strips on the tentacles. A 5-metre addressable LED strip with a waterproof silicon layer was used in this prototype. This LED strip was divided to eight equal strips. Figure 5.61 shows one of the LED strips for a tentacle that is connected to an extension wire to the Raspberry Pi pinout. Each tentacle had 37 addressable LEDs.

Figure 5.61. LED strip with the extension wire

There were two buttons to separately switch on and off the Raspberry Pi and the LED strips with speakers (see Figure 5.62). These buttons were designed to increase the duration of the power-bank operation time for each charge.

Figure 5.62. Buttons to switch on/off the Raspberry Pi and the LED strips with speakers

Figure 5.63 shows Olly after assembly of the tentacles with LEDs and attachment to the body.

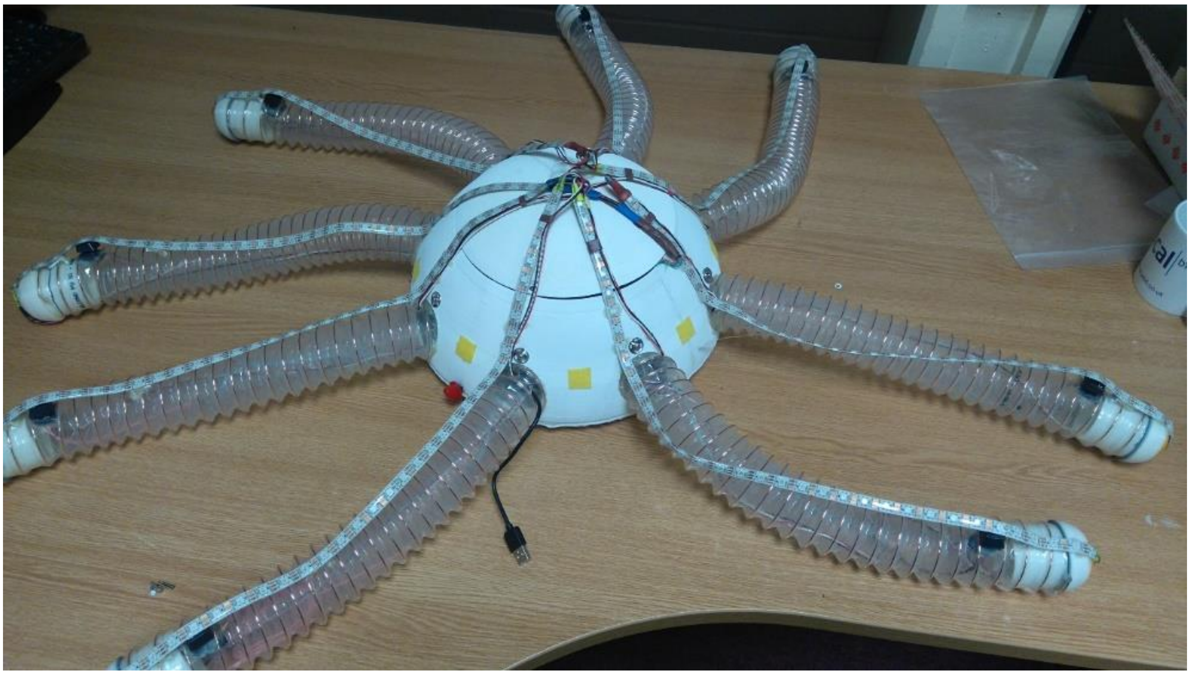


Figure 5.63. Assembly of Olly

Raspberry Pi 3B was placed in the body of Olly to control push buttons, LED strips and speakers. This derived its power from a dedicated 20000 mAh power bank, providing ten hours of continuous working time. The other identical power bank was placed to provide the necessary power for the LED strips and speakers. There was also a small electronic circuit, which provided the necessary voltage for the data signal input to the LED strip.

According to the design idea, the final look of the tentacles was to be soft and fluffy. The LED strips were supposed to be under the fabric. One of the concerns was to make sure that the brightness of LED strip was enough to have a visible shining tentacle during operation. In view of this requirement, a number of different fabrics from different companies were explored. Finally, it was decided to use sensory microfibre fabric to sew a cover for the tentacles and the body. Microfibre is an easily washable fabric, pleasant to touch, highly durable and safe.

Due to health and safety requirements, it was important to make it possible to remove the fabric cover from the toy for washing when necessary. As the fabric fit the tentacles tightly, as it was supposed to do, it was necessary to make sure that they could easily be put on to the tentacles without damage to the LED strips and push buttons. It was therefore decided to put nylon bags on the tentacles as well. In order to make the correct, custom-made sized bags, the circumference of the tentacles was multiplied by 1.2 to give a bigger diameter for the cylindrical bag which would facilitate fitting. Figure 5.64 shows one of the tentacles with this protective transparent nylon layer before fitting the fluffy fabric cover. The nylon layer also protected the tentacles if liquid was spilt on them.

Figure 5.64. Tentacles in the nylon protective cover and fabric cover

In order to fix the fabric covers on the tentacles, it was decided to use metallic attachable snap buttons to connect them to Olly's body (see Figure 5.65).

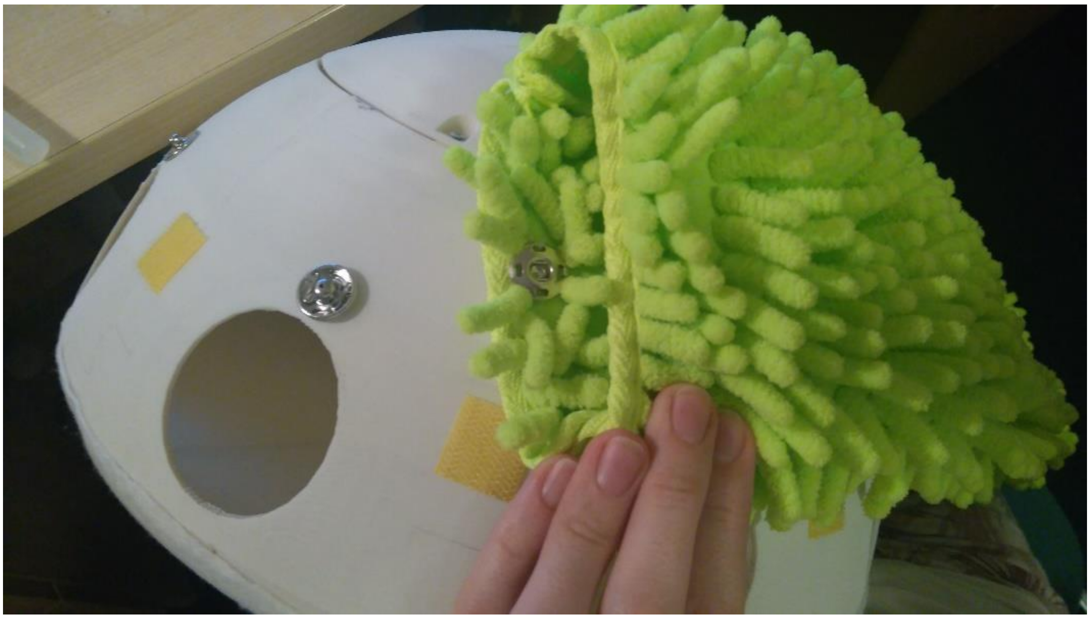


Figure 5.65. Fixing fabric cover to the body

The final shape of the assembled Olly is presented in Figure 5.66.

Figure 5.66. Octopush Olly

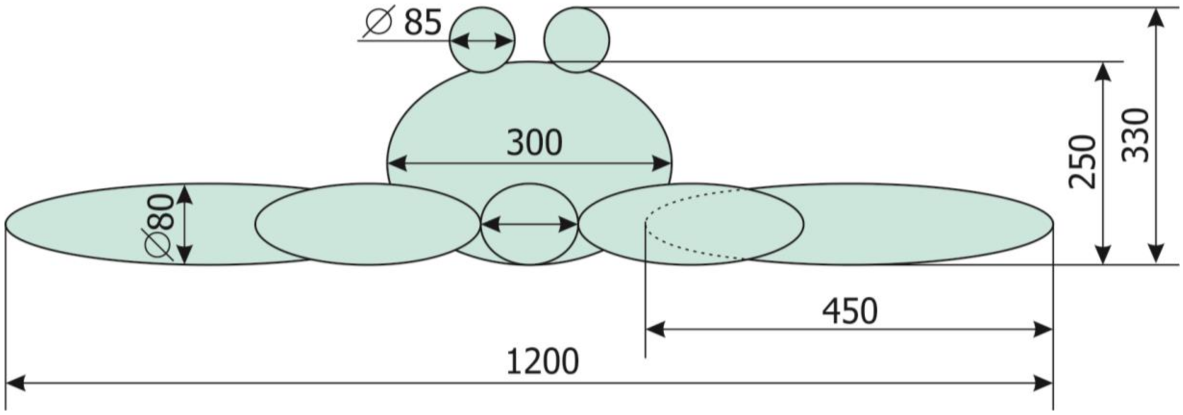


Figure 5.67. Dimensions of the final prototype (Olly presented schematically)

5.7 Health and safety

For health and safety reasons, the use of any objects that can be of danger to children is prohibited. Any trial of a new model of play equipment for use in special settings and by vulnerable populations (including children with cerebral palsy) requires approval by professionals (in this case, practitioners from NICE). To minimise the risks, these practitioners were consulted during the design stage about the use of specific materials and assisting facilities to ensure that the play equipment was safe for children to use. A number of steps, discussed in this design chapter, were taken to make the toys safe and as child-friendly as possible. Additionally, it was decided to evaluate possible risks in relation to stipulations by the Product Safety Forum of Europe, who have developed risk-assessment templates to improve safety for users of products and services. To explore the possible risks of using the designed play equipment, injury scenarios were imagined and then assessed, based on PROSAFE'S Risk Assessment Template for Toys (PROSAFE, 2015), intended for children older than 36 months and younger than 8 years (designated as vulnerable consumers). PROSAFE suggested 11 possible scenarios which could be assessed as follows:

0 - no chance of occurrence,

1 - minor chance of occurrence,

2 - probably will not occur,

3 - might occur if,

4 - probably will occur,

5 - definitely will occur.

The scenarios imagined for this research, together with the probability of their occurrence against this scale, when using the prototypes, were as follows:

Scenario 1: A child is playing with a toy with a small, detachable part. This small part comes off and the child accidentally swallows it.

The toys do not have small detachable parts which can be swallowed. All small parts, such as electronic elements, are hidden from users by being positioned inside the plastic body for Olly and the plastic base for Hetty, and securely covered. The smallest elements on the outside surface of the toys are acrylic circles on Olly's tentacles, which indicate where to push. They have a diameter of 60 mm and are securely sewed to the fabric. Therefore, the probability of this scenario when playing with Olly and Hetty is 0.

Scenario 2: A child plays with a toy that has sharp edges. The child gets in touch with the sharp edge and cuts fingers, tongue or lips.

Olly is covered with microfibre fabric, which is soft and fluffy. The acrylic circles at ends of the tentacles have smooth and polished surfaces. The probability of this scenario for Olly is 0.

Hetty has smooth elastic tentacles. The edge of the acrylic sphere that forms Hetty's body was carefully polished. Moreover, the length of the tentacles is about 46 cm, so the children would probably not be able to reach the edge of the body while sitting around the toy. The probability of this scenario for Hetty is 0.

Scenario 3: A child plays with a toy that has sharp points. The child touches the sharp point and suffers a small but deep cut.

Olly and Hetty do not have any sharp points. Therefore, the probability of this scenario when playing with the toys is 0.

Scenario 4: A child is playing with a toy with a protruding part. The child falls onto this protruding part. The child receives a puncture wound.

Olly and Hetty have perfect balance and a smooth shape with soft tentacles. They are designed to be used with the children sitting around them on the floor. Therefore, the probability of this scenario is 0.

Scenario 5: A child is playing with a toy with a non-compliant folding mechanism. The child releases the folding mechanism and the toy folds. The child's fingers are trapped between the folding parts.

There are no folding mechanisms in Olly and Hetty. The probability of this scenario is 0.

Scenario 6: The child plays with the plastic packaging of a toy. The child places it over the mouth and nose and airflow is temporarily blocked.

All the packaging materials were removed before the toys were played with and there was no possibility for the children to reach this. The probability of this scenario is 0.

Scenario 7: The toy includes no warning that it should not be given to children under 36 months.

There is no special sign on the toys to warn about age restrictions as they are prototypes and not ready-for-market objects. However, all playing sessions with the toys were conducted at NICE with children from primary-school groups (children from 5 to 7 years) and took place under the supervision of the practitioners and the researcher. The probability of this scenario is 0.

Scenario 8: The child is playing with a toy with a small, detachable suction cup. The child puts the suction cup in its mouth and it goes into the child's throat and blocks the airways temporarily.

There are no small, detachable suction cups on Olly and Hetty. The probability of this scenario is 0.

Scenario 9: A child plays with a non-compliant toy with button cell batteries. The child pulls out one or more batteries, puts it in the mouth and swallows it.

Olly and Hetty use 20000 mAh power banks which are securely positioned inside the toys with no access to them for children. The probability of this scenario is 0.

Scenario 10: The child is playing with a toy that contains expandable material. The child puts the expandable material in its mouth and swallows. The expandable material gets stuck in the upper airways and blocks them so the oxygen flow to the brain is blocked.

There are no expandable materials in the designed toys. The probability of this scenario is 0.

Scenario 11: The child is playing with a toy with small, detachable magnets. The child pulls off more than one magnet and puts them in its mouth. The magnets go into the child's digestive system, which causes internal wounds because they attract each other in the intestines.

Olly and Hetty have speakers, inside which one of their components is a magnet. However, the speakers are hidden inside the toys and cannot be reached by the children. The probability of this scenario is 0.

Based on the above, the injury level of both toys is appropriate. The toys are safe to be used by children older than 36 months.

5.8 Conclusion

This chapter has outlined the key issues regarding the process of developing the final design of the Undersea Friends play environment. This environment focuses on encouraging social interactions between children, mediated by the toys it includes. Encouraging the development of peer-related social competence of children with cerebral palsy is a challenging aim and addresses challenging issues about the intricate nature of peer social interactions, relational play and toy design features.

The playing process with Undersea Friends is more intuitive than the actual building of social interactions and relationships outside play. When playing with the toys, simple play actions result in engaging and enjoyable experiences for children, which assist in developing their social skills. In this way, children may begin to associate turn-taking, collaboration, sharing and other social skills with fun and play.

The next chapter presents findings from the design intervention and reveals children's engagement with Olly and Hetty, their behaviours during their play and emergence of their peer-related social interactions.

6 PEER INTERACTIONS THROUGH ENGAGEMENT WITH OLLY AND HETTY

6.1 Introduction

This chapter discusses the findings from the second data collection, which was conducted during the implementation of the design intervention and followed the same methodological model as in data collection 1. The children were observed during play sessions with Olly and Hetty, using non-participant observations. Instead of parental interviews, used in the first data collection, a focus-group discussion with conductors was carried out. This was because the conductors were present or worked with the children during the play sessions with the design intervention. They could therefore give professional feedback regarding the effectiveness of the equipment and the children's behaviours, and so contribute to overall judgements being made about successful elements of the toy designs and aspects which needed further development.

6.2 Observations of children playing with Olly and Hetty

This section presents the findings from the observations, which were conducted to explore the following questions:

1) How engaging was Olly and Hetty for the children?
2) Which social skills did the children demonstrate and practise during the play sessions with Olly and Hetty?

Finding the answers to the above questions aimed at evaluating the effectiveness of the toys, the conceptual design model and the design criteria which formed a basis for designing them. The data recorded during the observations were analysed thematically. This involved familiarisation with the data, coding, thematic search, defining themes, refining predetermined themes, and writing up. The analysis was led by the research interest in the children's engagement with the toys and their social interactions mediated by these toys (deduction). Through iterative coding, the codes were collapsed into code groups and then further into three main themes (induction): familiarisation and play with the toys, engagement with the toys, and the peer-related social interactions of the children. Results of the children's behaviour during play, and their interactions with the toys and with their peers by means of the toys, also allowed the toys' performance to be compared against the design criteria to determine how effectively these were implemented in Olly and Hetty.

6.2.1 Children

The sample for the observations consisted of the same children as during the first data collection. All five attended NICE on a part-time basis on different days. This meant that different play groups were observed in order to see all five children. At the time of the observations, four children were 6 years old and one was 5 years old (almost six). A more detailed overview of the participating children was offered in chapter 4, section 4.4.1.

6.2.2 Setting and procedure

Prior to the observations, two visits to the school were undertaken. The first was for delivering, assembling and testing the prototypes. The second was for presenting the toys to parents and conductors, giving them an opportunity to ask questions regarding the toys and to share their first impressions of Olly and Hetty.

All the observation data were collected during 30-minute children's play sessions, with 15 minutes of play time with each toy. In total, five observation sessions were carried out during a period from 7th to 19th February, 2019, and notes were taken using pre-prepared recording sheets (see section 3.6.1). The data collected included the number of children and conductors present; the activities of the participant children during their play with the toys; interactions between child participants and the other children, including fellow child participants, and with conductors; and indicators of engagement and of social competence observed during the sessions and noted just afterwards. An overview of the observations carried out is presented in Table 6.1.

Table 6.1. Overview of observations

	Child A	Child B	Child C	Child D	Child E
Date of observation	7.02.2019	12.02.2019 19.02.2019	12.02.2019 13.02.2019 14.02.2019	14.02.2019	07.02.2019 13.02.2019
No of children present	5	6, 5	6, 5, 6	6	5, 6
No of conductors	4	4, 4	4, 4, 4	4	4, 4

The observations were conducted in the same room as those before the design intervention. Therefore, the setting had no additional impact on the data collection. It was a spacious room where the play environment was organised with children sitting on rubber mats around the toy. This was in the centre of the group and each Child Could reach it to participate in play. The groups consisted of five or six children, so during the play with Hetty, who has six tentacles, each child was sitting near one tentacle. When children played with Olly, who has eight tentacles, they could reach one or two tentacles.

At the beginning of the first play sessions, the toys were introduced to children as "Olly the Octopush" and "Hetty the Hexapush". Some children had already seen them when they were presented to their parents and conductors, while others were meeting them for the first time. Figure 6.1 presents photos of some of the children taken during their first play with Olly and Hetty. These were taken just after the presentation of the toys to the parents and conductors, when these children had been present and it was decided to show them the toys as well. At that time, the toys had illumination and sound but did not yet work properly and still required some minor revisions. The photos depict the children together with the conductors, getting familiar with and exploring Olly and Hetty. In contrast to these photos, during the data collection only one toy was present for a 15-minute play session, after which it was replaced by the other for another 15 minutes. As mentioned earlier, the children sat closer around the toy in a circle. Nevertheless, these photos are illustrative of how the conductors supported the children physically and verbally, of the environment around, the scale of the toys in relation to the children, and the typical sitting position of the children during the play sessions.

Figure 6.1. Playing with Olly and Hetty for the first time (with the permission to use)

6.2.3 Findings

The findings of the research are discussed in three categories according to the three themes defined through the data analysis listed above. The analysis of the observations provided valuable insights into how children responded to the toys during the play sessions, how they approached them, how they interacted with them and with their peers, the role of the conductors during the play and the type of help required from the conductors so the children could participate actively in the playing process. Examples of the completed recording sheets are available in Appendix C.

Getting familiar and playing with Hetty and Olly

The children's first reactions and behaviour, when they first saw Olly and Hetty, are outlined for each child in Table 6.2 and show how they responded in different ways. In the play session with Olly, Children A and E gently touched the tentacles almost immediately. Children C and D watched at the beginning but touched the tentacles when they saw how other children were playing. Child B did not want to touch Olly during the first minute, even when the conductor encouraged her. She moved to show that she wanted to touch it after she got used to it and observed the others playing. The initial reaction of Child B may be seen as natural caution toward a new object. At the same time, she was aware of the situation and curious about how other children played with Olly. In the play session with Hetty, three of the five children tried to touch the toy almost immediately after its introduction. The other two first explored Hetty visually. The conductors introduced the toys, they were attentive and ready to provide physical assistance when the children needed it.

Table 6.2. Overview of the children's first reactions to Olly and Hetty

	Getting familiar with Olly	Getting familiar with Hetty
Child A	When Child A saw Olly, she smiled and immediately touched the tentacle. She did not press on it but stroked the soft fabric. Then she pressed on the coloured circle (area with a button placed underneath). She smiled and was surprised when the light ran from the end of the tentacle.	When Child A saw Hetty she was very curious and touched the tentacle. The tentacle lit up and she smiled.
Child B	Before the first play session the child had already seen both toys as she was with her mother at the presentation. On the day of the first play session, she was not feeling well and joined the play five minutes later than the other children. In this session children played first with Olly. The conductor asked children to present the toy and tell the toy's name to Child B. She listened and observed but did not try to touch or play with Olly. When the light came to her tentacle (the one closest to her), the conductor tried to encourage her, but she did not move. She was aware of the situation and observed for a while how other children pressed on tentacles when the light came to them. When the light came to her tentacle for the third time, she moved to show that she wanted to touch it. As this child has many involuntary movements and weak arms, she needed personal help. When the conductor helped her to press on the tentacle, she smiled and tried to touch more of the soft sensory fabric on it.	When Child B saw Hetty she smiled and began exploring the toy visually. As soon as another child first touched the tentacle and Hetty produced a short sound and a light, she touched the tentacle close by her feet. She had already discovered this strategy of playing from the play session with Olly and was engaged from the first minute.
Child C	In this first session for Child C there were children who had already played with Olly. They therefore knew how to play and Child C observed these other children first. When the light came to her tentacle, she looked around and asked "Me?". The conductor replied "Yes" that it was her turn. Child C gently touched the coloured lit-up circle and then pressed on it. She smiled and looked at others when the light ran through the whole toy.	When Child C saw Hetty, she first explored the toy visually. Then she gently touched the tentacle next to her. She smiled and looked at others when the light appeared, in order to share her enjoyment of the experience and this first impression.
Child D	When Child D first saw Olly, there were children who had already played with the toy. They knew how to play and Child D observed these other children first. Then he touched the tentacle next to him and smiled. The child looked happy.	When Child D saw Hetty he smiled, was very curious and tried to touch the tentacle. The tentacle lit up and he vocalised and smiled.
Child E	When Child E saw Olly, she smiled and gently touched the soft fabric. She visually explored Olly and touched the tentacle again. She did not press on the coloured circle (area with a button placed underneath) and just touched the soft texture of the tentacle. She said: "That's very cool". Then she pressed on the circle and smiled when the light ran from the end of the tentacle and back.	When Child E first saw Hetty she smiled and said: "Very cool, it's magic!". She was very curious and immediately touched the tentacle. The tentacle lit up and she said happily: "I can do it! I love it".

The overview of how each child played with Olly and Hetty is presented in Table 6.3.

Table 6.3. Playing with Olly and Hetty

	Playing with Olly	Playing with Hetty
Child A	Child A pressed on the tentacle a few times and observed what happened. The light ran forward and back. Then she noted that the end of one tentacle had lit up and she started to watch. She stroked the soft texture of the tentacle almost all the time. After some time, she understood that she should press on the circle when the light came to her tentacle. She looked very happy, smiled and clapped her hands when Olly started to sing. She also vocalised along with Olly's song every time it was activated. She tried to play with two tentacles and waited for her turn to press. She was aware and engaged in the playing process and did not miss her turn. She was the only child who tried to touch Olly's head. She looked happy and smiley.	Child A was enthusiastic and active during the play with Hetty. She pressed on the tentacle next to her and when she got a feedback, she smiled and looked at others to see their reactions. Although the tentacle could be activated by pushing on any part of it, she explored the whole tentacle by pressing on different parts. After some time, she understood that to hear the song and to see water fountains with illumination, the children should cooperate. She successfully played with Hetty and looked smiley. Child A remembered the name of the toy and when one of the conductors accidentally called the toy "Olly", she noticed this and vocalised to say that it was Hetty.
Child B	When Child B got used to the toy and tried to touch it, first with the help of the conductor, she looked more relaxed. She could not play with the toy with her hands without continuous help from the conductor. However, she found her own strategy of communication with Olly and touched the toy with her feet. The conductor noticed this and took off Child B's socks, so she could feel the sensory surface of Olly. Child B looked happy and smiled a lot. She pushed and touched the tentacle with her feet and was fully engaged. After a while, she started to watch more and gradually understood that she should wait for her turn to press on the tentacle in order to see the light running across the whole toy. When children got a reward feedback and Olly sang its song, she vocalised and smiled with the song.	Child B was actively engaged with Hetty. She looked smiley and happy. She pushed the tentacle with her feet and smiled. First, she and other children played chaotically and she pushed the tentacle to get a short sound and to see the light inside. When another tentacle was activated by another child, she looked at it and at the child who had pushed it. She watched others and smiled when she pushed the tentacle herself. When the children got a reward feedback, she focused on Hetty's body with water fountains and illumination inside. After a while, she understood that to see the fountains and to hear Hetty's song, she and others needed all to push on the tentacles and to cooperate. As soon as Hetty finished the song, Child B started to push her tentacle. She also understood that when she pushed the tentacle repeatedly, it changed colours, so sometimes she actively pushed the tentacle many times in a row. Although the tentacles could be activated by pushing on any part, there were places which required less effort (upper middle) and more effort (end and sides of the tentacles). Child B explored her tentacle with her feet and found out how to push it with less effort.
Child C	Child C understood how to play quickly, she waited for her turn and then pressed on the circle. She smiled every time when the light came to her. She often continued to keep the tentacle in her hands after she had pressed on it because of the soft sensory fabric. She touched this and explored the surface. She was aware of the play process and visually followed the light. She started to vocalise with Olly's song later than other children. First, she vocalised quietly but after a while she became more relaxed and vocalised louder. In the second play session she was responsible for two tentacles and looked very happy.	Child C was actively engaged with Hetty during all play sessions. First, she pushed the tentacle chaotically to get the short sound and to see the light. Sometimes, she pressed on the tentacle many times in a row to see changing colours inside. When the children got reward feedback, she smiled and pointed to Hetty's body with water fountains and illumination inside to share her emotions with peers. When Hetty finished the song, Child C vocalised to Hetty so that the toy started singing again. She vocalised with Hetty's song and smiled a lot. She did not want to finish playing when the sessions came to their end.

	Playing with Olly	Playing with Hetty
Child D	Child D needed continuous physical help from the conductor to maintain a sitting position, as he has severe cerebral palsy. He was inquisitive and enthusiastic during play. Despite difficulties with fine and gross movements, he tried hard to press on Olly's tentacle, often needing physical help from the conductor. Gradually he understood that he should wait for his turn to press on the tentacle. When children got a reward feedback and Olly sang the song, he looked happy, vocalised "Aaaa" to sing with Olly and raised his arms. He smiled and vocalised every time when Olly sang. He was aware and engaged in the playing process and did not miss his turn to press on the tentacle.	Child D was enthusiastic during the play with Hetty. It was easier for him to press on Hetty's tentacle than to press on Olly's. He pushed the tentacle next to him and looked happy when he got a feedback. When Child D heard the song and saw water fountains with illumination, he vocalised with Hetty's song and made movements, like dancing. Child D vocalised to call Hetty by name. He successfully played with the toy and looked engaged and smiley.
Child E	Child E pressed on the tentacle a few times and started to watch what other children were doing. She noted that the end of one tentacle lit up and pressed on her tentacle. The light ran forward and back. She repeated her actions and again started to observe. She heard how the conductor told another child whose tentacle was lit up to press on it. Child E watched and waited. When the light came to her tentacle, she knew that she should press on it. She pressed on the circle and followed how the light run through the whole toy. She looked very happy, smiled and clapped her hands. After this she followed the game and always pressed on the circle when the light came to her. Sometimes as she waited her turn, she stroked the sensory surface. When Olly started to sing, it was a fun for her and she was the first child who sang with the toy. She sang Olly's song every time when it was activated. Sometimes she tried to move in a dancing way or clapped her hands. She looked happy and smiley.	Child E was enthusiastic and active during the whole of both play sessions. She asked: "Is it Octopus?", "What is the name?". She pressed on the tentacle gently and when she got a feedback from Hetty, she smiled and looked at others to see their reactions. She looked happy and commented: "Easy to play, amazing!", "I can do it by myself". When she heard Hetty's song, she moved as if she was dancing and sang the song. On the third time she remembered part of the lyrics and sang with Hetty together. She soon understood that to hear the song and see water fountains with illumination, other children also had to push the tentacles, so when somebody did not do that, she looked at that Child And waited. She played using her left hand first (the right side of her body was weaker than the left side). Then the conductor asked her to use her right hand and she worked hard to push the tentacle. She did not want to finish playing when the sessions came to their end and pressed on the tentacle a few times more.

Once the children had become acquainted with the toys, all five children were active players and showed a high level of concentration and interest throughout the sessions. Although physical movements were challenging for them, as all had either moderate or severe cerebral palsy, they all found their own strategies to play with Olly and Hetty.

Nevertheless, qualitative differences in their engagement could be observed. Two of the five children required continuous physical support from conductors. These conductors helped them to keep their balance and also to press on the tentacles, for example when a child tried to lean forward or move his hands intentionally in order to play. Another child (Child B) played using her feet. The conductors praised children when they physically tried hard or successfully took their turns or cooperated. Some children quickly understood how to play to get a reward feedback from the toy, while others watched and copied their behaviour at first. After 2 – 3 minutes from the start of the first session, all the children were engaged in playing and pressing the tentacles and were smiley and emotional. When the conductors said that it was time to finish, three of the five children continued playing a few minutes more.

Engagement with the toys

A number of the indicators of engagement (developed in section 3.5.1, Table 3.1) were observed during the play sessions. A summary of the indicators demonstrated by each child while playing with Olly and Hetty is presented in Table 6.4 and Table 6.5 respectively.

Table 6.4. Indicators of engagement demonstrated by the children during play with Olly

Indicators of engagement with Olly				
Child A	**Child B**	**Child C**	**Child D**	**Child E**
Behavioural engagement: Physical contact: - touching, stroking, pressing on the tentacle, - touching Olly’ s head. Non-physical contact with the toy: - looking at the toy, - observing how it worked, - listening to Olly’ s song, - vocalising to the toy, for instance, vocalising to Olly to say “ goodbye” at the end of the play session, - vocalising with Olly during Olly’ s song. **Emotional engagement:** - positive facial expressions, for instance, spontaneous smiling and happy face, - smiling when Olly started to sing, - physical movements to express emotions, - clapping hands, - vocalising with Olly’ s song. **Cognitive engagement:** - understanding how to play with the toy, - counting the tentacles.	**Behavioural engagement:** Physical contact: - touching the toy with feet to feel the soft texture of the tentacle, - pushing button on the tentacle with feet, Non-physical contact with the toy: - looking at the toy, - observing how it worked (when the light and sound appeared), - listening to the toy’ s song and melody. **Emotional engagement:** - positive facial expressions, for instance, spontaneous smiling, - smiling every time when it was her turn to press on the tentacle, - physical movements as a signal of excitement, - curiosity, for instance, a little confused at the beginning but watched and finally joined the play, - exploration of the toy by watching and through physical touch, - vocalising with the reward song of the toy. **Cognitive engagement:** - understanding how to play with the toy, - finding own strategies for playing, such as playing with the toy by feet.	**Behavioural engagement:** Physical contact: - touching, pressing on the tentacles. Non-physical contact with the toy: - looking at the toy, - observing how it worked, - listening to the toy’ s song. **Emotional engagement:** - positive facial expressions, for instance, spontaneous smiling and happy face, - smiling every time Olly started to sing, - vocalising with Olly’ s song. **Cognitive engagement:** - understanding how to play with the toy, - counting Olly’ s tentacles.	**Behavioural engagement:** Physical contact: - touching and pressing on the tentacle. Non-physical contact with the toys: - looking at the toy, - observing how it worked, - listening to Olly’ s song, - vocalising to the toy, - vocalising with Olly during Olly’ s song. **Emotional engagement:** - spontaneous smiling and happy face, - smiling when Olly started to sing, - raising arms to express emotions, - vocalising with Olly’ s song. **Cognitive engagement:** - understanding how to play with the toy.	**Behavioural engagement:** Physical contact: - touching, pressing on the tentacle using both left and right hands. Non-physical contact with the toy: - looking at the toy, - observing how it worked, - listening to the toy’ s song, - speaking to the toy, for instance saying “ Hello” to Olly at the beginning of the play sessions and “ Bye” at the end. **Emotional engagement:** - positive facial expressions, for instance spontaneous smiling and happy face, - smiling every time Olly started to sing, - physical movements to express emotions, - movements like dancing, - clapping hands, - singing Olly’ s song, - positive comments during play. **Cognitive engagement:** - understanding how to play with the toy, - naming colours of the tentacles.

Table 6.5. Indicators of engagement demonstrated by the children during play with Hetty

Indicators of engagement with Hetty				
Child A	**Child B**	**Child C**	**Child D**	**Child E**
Behavioural engagement: Physical contact with the toy: - touching, pressing on and pushing the tentacle by hand, - exploring the whole surface of the tentacle. Non-physical contact: - looking at the toy, - pointing to it, - observing how it worked, - listening to the toy’ s song, - vocalising to the toy. **Emotional engagement:** - positive facial expressions, for instance, smiling, - smiling every time Hetty started to sing, - vocalising with Hetty’ s song. **Cognitive engagement:** - understanding how to play with the toys, - counting Hetty’ s tentacles, - understanding where to push with less effort.	**Behavioural engagement:** Physical contact with the toy: - touching, pushing and exploring the tentacle with feet. Non-physical contact: - looking at the toy, - observing how it worked (when the light, sound and water fountains appeared), - listening to the toy’ s song and melody. **Emotional engagement:** - positive facial expressions, for instance, spontaneous smiling and happy face, - smiling every time when Hetty started to sing, - exploration of the toy visually and physical with feet, - vocalising with the reward song of the toy. **Cognitive engagement:** - understanding how to play with the toy, - finding own strategies for playing, such as playing with the toy with feet, - understanding where to push with less effort.	**Behavioural engagement:** Physical contact with the toy: - touching, pushing, pressing on the tentacles. Non-physical contact: - looking at the toy, - observing how it worked, - listening to the toy’ s song, - pointing to the toy, - vocalising to the toy. **Emotional engagement:** - spontaneous smiling and happy face, - smiling every time when Hetty started illumination and water fountains, - vocalising with Hetty’ s song, - curiosity. **Cognitive engagement:** - understanding how to play with the toys, - counting Hetty’ s tentacles.	**Behavioural engagement:** Physical contact with the toy: - pushing the tentacle with both hands. Non-physical contact: - looking at the toy, - observing how it worked, - listening to the toy’ s song, - vocalising to the toy. **Emotional engagement:** - positive facial expressions, for instance, smiling, - smiling every time Hetty started to sing, - physical movements to express emotions, for instance raising arms, - vocalising with Hetty’ s song. **Cognitive engagement:** - understanding how to play with the toy.	**Behavioural engagement:** Physical contact with the toy: - touching, pressing on and pushing the tentacle with both hands. Non-physical contact with the toy: - looking at the toy, - pointing on it, - observing how it worked, - listening to the toy’ s song, - speaking to the toy, for instance, saying “ Hello” to Hetty at the beginning of the play sessions and “ By” at the end. **Emotional engagement:** - positive facial expressions, for instance, spontaneous smiling and happy face, - smiling every time Hetty started to sing, - physical movements to express emotions, - singing Hetty’ s song, - positive comments during play. **Cognitive engagement:** - understanding how to play with the toy, - counting Hetty’ s tentacles, - understanding where to push to make less effort.

Peer-related interactions mediated by the toys

The overview of how children interacted with their peers during play with the toys is shown in Table 6.6.

Table 6.6. Interactions with peers during play with Olly and Hetty

	Interactions with peers during play with Olly	Interactions with peers during play with Hetty
Child A	Child A observed how other children were playing with Olly. She smiled at others and sometimes vocalised to share her emotions. When children did not press on the tentacles in their turn, she looked at them waiting and one time she vocalised to a child to show that he should press on the tentacle. Once Child A noted that the leg of one child was preventing another child from reaching the tentacle. She pointed and vocalised to that child so that he moved his leg a little bit. Child A actively participated in the play, interacted with others and did not miss her own turn.	Child A was curious, active and engaged with Hetty. She shared her emotions with other children and conductors, looked at their reactions and smiled to others. She actively cooperated with the other children.
Child B	During two observation sessions, Child B showed different levels of interactions with other children. She watched how other children were playing with Olly and visually followed the light, but sometimes it seemed she was engaged more in her own play with Olly's tentacle. However, she was aware of who should press on the tentacle next and did not miss her own turn. When her tentacle lit up, before she pushed on it, she sometimes looked at other children and smiled to show that it was their turn. She cooperated with peers successfully to get the reward feedback. She also vocalised to sing Olly's song with the other children.	During two play sessions Child B watched how other children were playing with Hetty, copied their behaviours and smiled at others. After the first 3-4 minutes, she followed the play and was ready to push the tentacles with other children when Hetty stopped singing its song. She successfully cooperated with others and found her strategy to participate in the play. Sometimes she was too engaged in watching how the other children pushed or pressed on the tentacles and forgot to push herself. In these rare situations the conductor who was helping her to sit encouraged her to push as well. She always responded and smiled when she got a feedback from Hetty.
Child C	Child C observed how other children were playing with Olly and visually followed the light. She looked at children whose turn it was to press on the tentacles. When her tentacle lit up, before she pushed on it, she often looked at other children and smiled. She cooperated with peers successfully and vocalised with children to sing Olly's song.	Child C observed how other children were playing with Hetty and smiled at them. She was aware who pressed on the tentacle and who did not and was ready to push her tentacle when Hetty stopped singing its song. She successfully cooperated with others. She always smiled when she got a feedback from Hetty and sometimes vocalised to attract the attention of other children and conductors. After she realised that other children also had to press on the tentacles to get reward feedback, she looked at those who did not press and waited.
Child D	Child D observed how other children were playing with Olly. He smiled at others, vocalised and raised his hands to share emotions. He actively participated in the play, interacted with others and did not miss his own turn.	Child D was active and engaged with Hetty. He actively shared his emotions with other children and conductors. He cooperated with the children and followed the play.

	Interactions with peers during the play with Olly	Interactions with peers during the play with Hetty
Child E	Child E observed how other children were playing with Olly. She shared her positive emotions with other children and conductors, smiled at them and sometimes made comments. When children did not react to the light, she looked at them and waited. She always sang Olly's song and one time touched the child who was sitting next to her to attract his attention or invite him to sing with her. She understood how to play, actively interacted with others and did not miss her own turn.	Child E was engaged with Hetty and looked smiley and happy. She wanted to share her emotions with other children and conductors, looked at their reactions, smiled at others and made comments. She also asked the researcher: "Would you like to try?". After some time, she cooperated with other children successfully.

The children interacted both with their peers and with the conductors during play. All children demonstrated positive emotions and shared these with other children and conductors. They also looked at and smiled to their peers when, for example, they pressed on the tentacles and these lit; they took turns, cooperated and sang or vocalised Olly's and Hetty's songs together (four of the five children had little or no recognisable speech). The children evidently perceived Olly and Hetty not simply as toys but also as "live creatures". They waved and vocalised to greet them at the beginning, sometimes called to them during play and said goodbye to them at the end.

A summary of the indicators of social interactions with peers observed for each child while playing with Olly and Hetty is presented in Table 6.7.

Table 6.7. Indicators of peer-related social interactions demonstrated by the children

Child A	Child B	Child C	Child D	Child E
Indicators of peer-related social interactions during play with Olly				
- observing other children, - making eye contact with other children, - smiling at and with other children, - listening to others, - speaking to others, - taking turns, - shared attention, - cooperating.	- observing other children, - making eye contact with other children, - smiling to and with other children, - listening others, - vocalising with others, - taking turns, - cooperating.	- observing other children, - making eye contact with other children, - smiling to and with other children, - listening to others, - vocalising with others, - taking turns, - cooperating.	- observing other children, - smiling at and with other children, - listening to others, - vocalising to others, - taking turns, - shared attention, - cooperating.	- observing other children, - making eye contact with other children, - smiling at and with other children, - listening to others, - speaking to others, - taking turns, - shared attention, - cooperating.
Indicators of peer-related social interactions during play with Hetty				
- observing other children, - smiling to and with other children, - vocalising with others during Hetty' s songs, - vocalising to others, - cooperating, - shared attention.	- observing other children, - smiling to and with other children, - listening to others, - vocalising with others, - cooperating, - shared attention.	- observing other children, - making eye contact with other children, - smiling to and with other children, - listening to others, - vocalising with others, - cooperating.	- observing other children, - smiling to and with other children, - vocalising with others during Hetty' s songs, - vocalising to others, - listening to others, - cooperating, - shared attention.	- observing other children, - smiling to and with other children, - singing with others, - speaking to others, - cooperating, - shared attention.

The findings from the observations offered insights into the children's behavioural, emotional and cognitive engagement with Olly and Hetty. Analysis of the observational data meant that they could then be related to the indicators of social competence. This is discussed below in section 6.4.2.

6.3 Focus-group discussion with conductors

This section presents findings from the focus-group discussion with the conductors, who provided critical feedback based on their observations of the children's behaviour, engagement and peer-to-peer interactions during play sessions with the prototypes. Data from this discussion complemented the observations and helped to provide an independent view of the children's engagement with the toys and their interactions with each other, as well as facilitating triangulation of data obtained from the researcher's own observations.

6.3.1 Conductors

Five conductors who regularly worked with the participating children and were present at either four or five of the play sessions with the toys were chosen as interviewees. Four were female and one male.

6.3.2 Procedure

A semi-structured group discussion with these conductors was conducted in a single Skype session after the design interventions had been completed. It was conducted in a conversational manner and all interviewees had an opportunity to express their thoughts on each question asked by the researcher. A list of these questions is available in Appendix D. The session was voice-recorded with the interviewees' permission. As in data collection 1, thematic analysis was used to analyse the data (Braun and Clarke, 2006). This involved familiarisation with the data, coding, thematic search, defining themes and writing up. Analysis combined deductive and inductive processes. The themes were generated deductively as the researcher was interested in how engaging the toys were for the children and what kind of social interactions happened between the children during relational play. The themes were then expanded and refined, using inductively generated themes from the coding. Two additional themes emerged from the data: design criteria incorporated in the toys and what could be improved in the toys.

6.3.3 Findings

This section provides findings from the focus-group discussion with the conductors. These further developed understanding of the children's engagement with Olly and Hetty, of their behaviours during the play and of their social interactions with peers, including how these were encouraged or hindered by the toys. Findings are presented according to the four main themes defined during data analysis: engagement with the toys; social peer-related interactions mediated by the toys; design criteria incorporated in the toys; and what could be improved in the toys.

Engagement with Olly and Hetty: All conductors stated that children were engaged with Olly and Hetty during all play sessions and that every child was able to play with the toys. One of them said: *"Everybody enjoyed playing with them [the toys]"*. Another conductor noted: *"Children had fun, we all had fun".* Although some children required physical support during the play, the conductors appreciated that there were different ways in which the children could interact with the toys. All the children were *"active and inquisitive"* players and gradually found their strategies of playing with Olly and Hetty.

To support this view, one of the conductors said that they had a new child in the group, who had arrived for the first time on the day when the play session with Olly and Hetty took place. Usually, it is quite a long process for new children to get used to the new school environment and new people, a few days to a few months perhaps, depending on the child. However, this new child was so curious and interested in the toys, that he immediately settled in and started to play with the the toys and, thus, with the other children.

Social interactions with peers mediated by Olly and Hetty: In the interview, conductors indicated that the children did not simply engage with the toys but that they also interacted with each other. The toys therefore performed their intended functions, with the children cooperating during their play with Hetty and taking turns while playing with Olly. Beside these two social skills, the conductors noted other indicators of social interactions amongst children, such as *"smiling to each other", "looking at each other", "doing things together" and "playing together"*.

Both toys were designed so that children would gather around them while playing. This was appreciated by two of the conductor-interviewees. One noted that gathering in a circle was *"a big advantage for children"*, as they could *"see each other, talk to each other"*. Another positive aspect was that children were actually in sitting positions during play. One interviewee said: *"For us it was good when children were sitting around"*. It meant the children could be more independent than, for instance, if they had been in a standing position, because the majority would then have required continuous physical support from an adult. It was also easier for the conductors to support from behind if the children needed physical help with, for example, keeping their balance while seated.

Design criteria implemented in the toys: In terms of physical properties of the prototypes, the conductors mentioned that the toys were "*nice and fluffy*", "*sensory*", "*colourful and funny*", and had "*excellent size*" for a small group of children to sit around. All five conductors noted that both toys were engaging and inclusive for children with different manifestations of cerebral palsy. For instance, one conductor said: "*Children of all abilities can play with the toys easily. Ideas are excellent*". Another conductor highlighted that the tentacles were "*tangible and can be touched by any part of the body*" to be activated. This meant that children could play with Olly and Hetty not only with their hands, which could be a challenge, but also with their feet, elbows, etc. The toys provided opportunity for every child to engage according to their own level of development, including those with less developed physical skills. One of the conductors mentioned that the toys were "*intuitive*", meaning that children could play with them with minimal guidance from adults. Even so, the physical assistance of the conductors was important and necessary, as the children had different implications of cerebral palsy and different levels of independence. The conductors recognised the children's intentions and could provide necessary help and encouragement.

What can be improved: In the interview, conductors also mentioned aspects of the toys which could be improved. One conductor noted that Hetty's tentacles needed to be attached more firmly to the body for easier transportation. During prototyping it had been decided to connect the tentacles to the body by hook-and-loop fasteners, in order to simplify the assembly and disassembly process. This way of connection worked well during the play sessions when Hetty was in a static position, but when there was a need to transport the toy into storage until the next play session, some tentacles disconnected from the body. Also, assembly of Hetty had been done by the researcher, and the conductors found this process not as straightforward. As Hetty is quite large, it would be convenient to be able to disassemble the toy quickly and easily. These issues would need to be addressed if the prototypes were to be produced as real toys.

Overall, the findings from the focus-group discussion revealed that the children demonstrated a number of the indicators of engagement and of social interaction during the relational play with Olly and Hetty. The findings from the interview supported the findings from the observations in these respects.

6.4 Discussion

Findings from the non-participant observations during the design intervention and from the group interview with conductors provided detailed information about children's engagement with the toys, their play behaviours and their peer interactions during play sessions. Data revealed how the toys encouraged social communication for each child with his or her peers.

6.4.1 Engagement with Olly and Hetty

The play equipment was new to the children and one of the concerns was how they would perceive the toys and what would be their first reaction. The observations showed that the children were mostly curious and ready to play. Four of the five children readily expressed their desire to play - they were excited, smiled happily and tried to touch the toys during the first minute of the session. Two actually touched the toys almost immediately and another two watched them first and then touched the tentacles themselves. The fifth child first observed the others while they were playing with the toy but took time before deciding to try herself. The conductor initially encouraged her to engage but then allowed her time first just to watch.

All five children expressed positive emotions. They showed excitement, looked happy and smiled, especially when they had feedback from the toys. They interacted with the play equipment in different ways and expressed their emotions differently too. During data collection the following indicators of engagement (see section 3.5.1) were noted among all target children:

Indicators of behavioural engagement:

- looking at the toys
- vocalising or speaking to the toys
- pushing, pulling, pressing on or squeezing tentacles of the toys
- listening to the toy's song.

Indicators of emotional engagement:

- positive facial expressions
- spontaneous smiling
- exploration of the toys
- singing or vocalising with the toys.

Indicators of cognitive engagement:

- understanding how to play with the toys
- finding own strategies of playing.

6.4.2 Peer-related social interactions

The toys allowed the creation of a level playing field for children to participate in relational play. All target children were involved in the playing process and actively interacted with the toys, although they received physical assistance or verbal encouragement to do so. Relational play, in its turn, was a good basis for spontaneous social communications and interactions to occur.

Findings from the data collection before the design intervention showed that there was plenty of child-adult communication at the school, while peer interactions could happen during group activities and were mainly structured and guided by conductors through group and personal instructions and support. While it was impossible to fully avoid adult facilitation because of the complexity of children's needs, an important aspect of these toys was to minimise this and to increase children's independence in play and in social interactions. The conductors introduced the toys at the beginning, supported physically two children who needed assistance in sitting, and sometimes praised the children when they tried hard or when they pressed on Olly's tentacles in their turn. At the beginning of the first play session, they also occasionally gave comments, such as *"Wait, please. It's not your turn"* or *"Look. You can push now"*. Overall, findings revealed that the play sessions with the toys were not structured or guided by adults; the role of the conductors was to give support when the situation required it.

Children's engagement with the toys led to relational play, which triggered different types of social interactions between them. They demonstrated different social skills, as were expected due to the design of the toys, as well as spontaneous social communication during their play. For example, when a child pushed or pressed on

Hetty's tentacle, it lit up and produced a short sound. This feedback attracted the attention of other children and they looked first at the active tentacle and then to the child who activated it. In the case of Olly, when the child pressed the button, the light passed from the end of one tentacle that was pressed through the body to the end of the second tentacle, which in turn remained lit up until the next press. The children visually followed these lights, as they led to the child who had to be the next to press on the active tentacle. Thus, the toy triggered social awareness: the children were conscious of the situation, watched each other and had visual contact.

Through this play, children successfully practised turn-taking with Olly and cooperation with Hetty. At the beginning (during the first two or three minutes), the reward feedback of the toys was activated by the children rather infrequently. An understanding that they should cooperate in order to get the reward feedback from Hetty came to the children gradually through practice. In the case of Olly, three children started to press on the tentacles in turn after a few minutes, while the other two received comments from the conductors who explained that they should take turns. However, even when children played with the toys without full understanding of how to trigger the reward feedback, they demonstrated social interactions mediated by the toys. The list of indicators of social competence which were observed during all play sessions in all the children at least one time, include the following:

- observing other children,
- making eye contact with other children,
- looking at other children, for instance, when the Child Did not push on Hetty's tentacle and therefore the children could not get the reward group feedback

from the toy, or when the Child Did not press on Olly's tentacle in his/her turn,

- shared attention,
- smiling at and with other children, for instance, to share positive emotions and excitement,
- talking, vocalising or gesturing to others, for instance, when the Child Activated the light of the toy's tentacle and vocalised to attract attention and share his/her achievement,
- listening to other children,
- taking turns during play with Olly,
- cooperating during play with both toys.

These indicators are among the main social skills which children develop as part of their growing social competence. The idea of the designed play equipment was to engage children in relational play and to encourage peer-related social interactions. Olly was developed to practise turn-taking and Hetty to practise cooperation. Findings demonstrated that the toys performed their main functions and created a level playing field for children.

Beside these social functions, both toys also created opportunities for practising other elements, such as tactile, visual and audio sensory skills, fine and gross motor movements, understanding positive emotions, knowing colours, counting, and understanding consecutive and cause-and-effect actions.

6.4.3 Implementation of the design criteria in Olly and Hetty

Based on findings from the observations and the focus-group discussion, the children demonstrated a high level of engagement and social interaction with their peers during the play sessions, albeit this engagement differed according to their levels of development and individual difficulties. This confirmed the relevance and effectiveness of the design criteria and design recommendations (see section 4.6.3 and 4.6.4) which had been implemented in the design of Olly and Hetty.

One of the challenging tasks of designing play equipment with its intended function of encouraging social communication was to create *flexibility* (or *open-endedness*) and to find a balance between this and functionality. As well as practising cooperation and turn-taking, the children demonstrated other aspects of learning through play. They counted the tentacles, named the colours and participated in imaginative play whereby they communicated with the toys as their 'friends'. All these actions provided evidence of flexibility in design of the toys. Indeed, this aspect could perhaps be developed further, so the toys could be used not only during play activities but also in more formal educational processes, for example, by making the tentacles of different lengths for measuring or by adding letters and numbers. The different scenarios of play and different activities the children demonstrated during their play also showed that the toys were *appropriate to levels of development of young children*.

Findings also provided evidence of the toys' *inclusiveness*. Children played with Olly and Hetty using their own strategies. For instance, they pressed on the tentacles with both hands, with one hand or with their feet. They pushed, pulled, drummed and stroked the tentacles, explored the texture, etc. Although the children were on different levels of development and had varied manifestations of cerebral palsy, all were able to play with the toys with minimal help from the conductors.

The five children were therefore all active players. They understood how to trigger individual feedback from the toys on their own and how to trigger group feedback independently or with minimal help from the conductors. This meant that Olly's and Hetty's design was sufficiently *intuitive* and offered appropriate *feedback for the children*.

Furthermore, the findings from the observations and focus-group discussion indicated that the children were engaged with the toys, they touched them, explored the texture of the tentacles (especially with Olly), stroked the soft fabric, explored the toys visually, observed the lights and sang the toys' songs. All of this meant that the toys were *sensory* and *visually attractive*.

The observed indicators of peer-related social competence provided evidence of the successful implementation of the design criteria from the first level (see section 4.6.3).

6.5 Conclusion

This chapter has discussed the findings from the data collection during the design intervention. It has revealed the first reactions of the children to the toys, their behaviours during play sessions, the levels of their engagement with the toys and their social interactions with peers as a result of their play.

Children participated in one, two or three play sessions with the toys but understood how to trigger group feedback in the first 2-3 minutes of their first session. All five children were active players, they did not require additional encouragement or motivation to participate and did not want to end the play at the end.

The role of the conductors was to provide support when a child required it and was focused mainly on two children who required continuous physical support to maintain their sitting position. Practising social skills was more an intuitive than a taught process for children while playing with Olly and Hetty. The children looked happy, excited and often smiled. Significant change was observed in children's verbal communication. During the data collection 1, the children tried to speak or vocalise mainly in the structured activities and were guided by the conductors. During their play with Olly and Hetty, however, they vocalised with the toys' songs without any external encouragement or instructions from adults. They also demonstrated varied social interactions and effectively communicated with their peers (according to their individual difficulties) through the toys. It is worth noting that the data collection was conducted in one specialist educational provision (the National Institute of Conductive Education), and to transfer the research findings to other provisions, further research is recommended. If design of the toys is to be developed further, the process of Hetty's assembly and disassembly should be simplified and the way of connecting Hetty's tentacles to its body should be more secure.

7 CONCLUSION

This concluding chapter summarises the research findings and original contributions to knowledge, reflects on the research limitations and provides recommendations for further research and practice in the area of designing play equipment to develop social competence of children with cerebral palsy.

7.1 Summary of the research: Outcomes and findings

This study sought to address and to answer the following research question through theoretical and empirical investigation: How can we design play equipment to develop peer-related social competence in children from 4 to 6 years of age with cerebral palsy? It explored how play equipment could contribute to the development of social skills through encouraging relational play and thus peer social interactions between children.

In response to the research question, in the literature review in chapter 2, this study investigated and brought together the key aspects of the research context. These were: children with cerebral palsy and their social competence as the conditions of the study; relational play and play equipment as a means to address the development of social competence in the children; and design approaches as a tool to design play equipment for engaging children in relational play.

The literature review revealed that support of children with cerebral palsy is often medically oriented and primarily addresses their physical and cognitive areas of development. However, manifestations of cerebral palsy are much broader than this. This study therefore addressed the development of children's social competence through engaging them in relational play by means of the play equipment. To achieve this, a conceptual design model of play equipment was developed (presented in sections 2.4.1 and 5.2). It was based on the idea of object-centred sociality (Engeström, 2005; Simon, 2010), where play equipment is treated as a central point and is a trigger of peer interactions between children.

On the basis of this model, design criteria for creating play equipment were developed. These criteria had two interrelated sets of indicators, where the first set comprised child-friendly design criteria and the second set comprised indicators of social competence. The model of and the design criteria for play equipment which contribute to the development of social competence in children with cerebral palsy served as a framework for the design development and intervention.

Chapter 3 presented the methodological basis for collecting and analysing data before and during the design intervention and for the design development and evaluation. It outlined the research approach, methods for data collection and analysis, design methods and strategies, and ethical considerations. The chapter also presented the indicators of children's engagement with the play equipment and indicators of social competence, which were formulated in order to examine the effectiveness of the designed play equipment and which provided the basis for the observations and thematic analyses.

Chapter 4 presented the analysis of the data collected at NICE before the design intervention. Findings from observing children and parental interviews gave an insight into the nature of social interactions with peers and adults for each child, the children's preferred toys and the role of these toys in their interactions, as well as the desired properties of the toys from the perspectives of parents and conductors.

Findings revealed that children mainly interacted with conductors by following instructions, smiling, vocalising and pointing. Peer interactions were observed during structured peer activities and were initiated and led by conductors, rather than by children. During these activities, the conductors provided personal and group instructions, encouragement and physical support in accordance with children's needs. Children often were more concentrated on their own tasks than on peer communication.

Findings also allowed the design criteria developed in chapter 2 to be refined and complemented and design recommendations for the play equipment to be formulated. Data from parental interviews highlighted the importance of self-confidence in children's peer interactions. Therefore, motivation, independence, courage and curiosity were added as concepts related to self-confidence to the second level of the design criteria. Data analysis also led to the formulation of design recommendations which were more specific and practical.

Chapter 5 presented the design development of the play equipment and described the process of building the prototypes for the design intervention. The thematic play environment, Undersea Friends, was devised to demonstrate how the design criteria could be used to develop play equipment which would engage children in relational play and, thus, in peer interactions. The environment consisted of several toy-friends, with each toy having been created to help children practise a particular social skill while also facilitating their peer interactions. Two toys, Octopush Olly and Hexapush Hetty, were chosen for implementation. Their prototypes were used in the evaluation.

Chapter 6 presented and discussed the findings from the design intervention where the children played with Olly and Hetty. The evaluation showed that all six children showed high levels of engagement with the toys. They were curious and excited, they smiled and actively explored the toys within the physical constraints of their disability. The toys provided opportunity for each child to engage according to his or her level of development. The children demonstrated a wide range of the indicators of engagement (defined in section 3.5.1), which confirmed the effectiveness of the child-friendly design criteria (defined in section 4.6.3).

Findings further revealed that the toys engaged children in relational play, which in turn provided opportunities for social interactions determined by the toys, and for spontaneous social communication. The children demonstrated a broad range of indicators of peer-related social competence (defined in section 3.5.2), such as observing other children, making eye contact with each other, looking at other children, shared attention, smiling at and with other children, talking, vocalising or gesturing, listening to each other, taking turns during play with Olly and cooperating during play with both toys.

The role of the conductors in the play sessions was facilitative, rather than leading, and in this way the children's independency in the play and in interactions with each other was encouraged and strengthened. The observation of indicators of social competence confirmed the relevance of the second set of design criteria, which pertained to the criteria of purpose and included modelling social skills and fostering self-confidence.

The results of the study indicated that the development of social competence in children with cerebral palsy can be effectively addressed through specialist play equipment which engages them in relational play and which creates a level playing field for children with different manifestations of cerebral palsy.

7.2 The design criteria and recommendations

This section presents the complete list of the design criteria and recommendations which were developed throughout this thesis and which provide practical guidance on how to design play equipment for children with cerebral palsy that facilitates the development of their social competence. The design criteria were developed in section 2.4.4, refined in section 4.6.3 and are represented here as a scheme with two levels (Figure 7.1Figure 7.1. The design criteria).

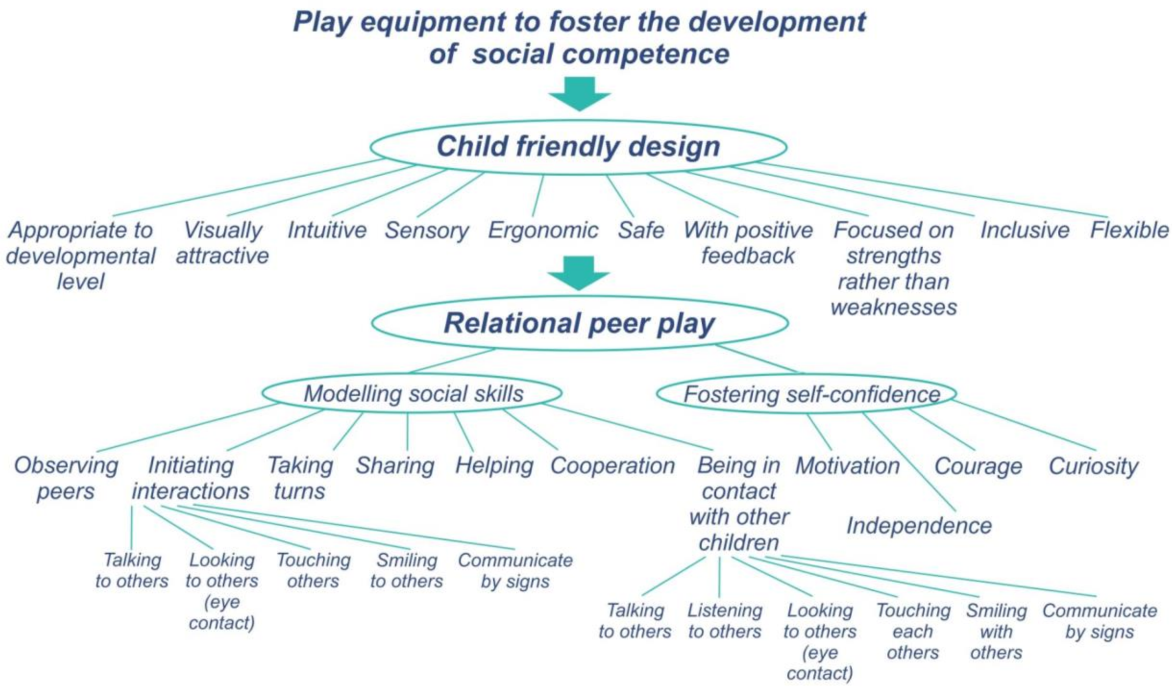


Figure 7.1. The design criteria

The first level comprises the child-friendly design criteria, which relate to making play equipment attractive and engaging and avoiding any barriers that children with cerebral palsy might otherwise encounter. Child-friendly design should be intuitive, sensory, visually attractive and developmentally appropriate, and should incorporate positive feedback to child users. It should be ergonomic, inclusive, flexible and safe.

The research has shown that play equipment designed in a child-friendly way can empower children to participate in relational peer play. Through their play with the equipment, children are encouraged to interact with each other and thus to practise social skills. This in turn fosters self-confidence and helps to develop their social competence. Social competence involves a range of skills and refers to the smooth sequential use of these skills within social interaction. The main social skills that early-years children ought to develop (defined and presented in section 2.3.1), include sharing, cooperation, taking turns, helping, initiating interactions and making contact with other children. Self-confidence is related to motivation, independence, courage and curiosity. Social skills and self-confidence are criteria of the second level.

To complement the design criteria, more specific design recommendations were formulated (see section 4.6.4), which are presented in Table 7.1.

Table 7.1. Design recommendations

Play equipment should be stable	Children may have involuntary movements, weak arms, poor muscle control, muscle spasms or tremors, which make it difficult to hold toys which often may slip from their hands. Stability of the toys allows children to play independently without continuous help from adults.
Play equipment should be without too many small pieces	Playing with the toys which consist of small pieces may be frustrating for children because of the physical implications of cerebral palsy. It can also divert children's attention from communication because of the potential challenges in use, even when social interactions are the main function of the play equipment.
Play equipment should be without sudden effects	Children may not notice very short effects, for example quick splashes of light, due to their level of dexterity and reaction time. Therefore, it is better to have, smoothly fading light, for example, and the duration of illumination should be at least a few seconds.
Play equipment should be washable	With regard to health & safety, toys should be made of washable materials.
Play equipment should be easy to hold	if toys require constant holding to play with, it may be a challenge for children to do so because of weak arms, lack of muscle coordination, muscle spasms, tremors, involuntary movements or clumsy movements, all of which are common representations of cerebral palsy. Texture may help to minimise a toy slipping out of hands, while a wrist strap may help children to return the toy back into their hands without adult's help.
Play equipment should encourage use of voice	Children may have delays in speech development or difficulty speaking. Toys which help in practising sounds and speech can assist in this issue.

7.3 Research contributions

This research makes several contributions to the field of design for health and well-being, specifically to educational toy design for children with cerebral palsy and to inclusive design and inter-sensory design in this context. It also contributes to the fields of sociology and education, specifically to the development of social competence in children with cerebral palsy. It provides a practical case study of how it is possible to design play equipment for children with cerebral palsy from 4 to 6 years of age to foster the development of their social competence.

In doing so, firstly, this study examined the notion of cerebral palsy and its implications for children's development and learning. The understanding of disability in general and cerebral palsy in particular went through a transformation. Starting from a deficit-orientated view, the research came to a more socially underpinned understanding of the implications of growing up with cerebral palsy that was primarily based on a Vygotskian view on the development of disabled children. Thus, while existing research projects have addressed social development of disabled children through special educational programmes and training, this research in contrast demonstrates how it is possible to encourage the development of social competence in children through specialist play equipment, which engages children in relational play, and how to create such equipment.

The second contribution is in establishing the term, "relational play", as a specific concept and category of play, where play is a medium for interpersonal interactions of peers participating through the physical play environment. The term, "relational", was inspired by the theory of relational aesthetic (Bourriaud, 2002), which refers to creating a physical environment (artefacts, installations, etc.) for realisation of a particular social situation and for facilitating community among viewers. This perspective corresponded particularly well with the understanding of play in the context of the present study. Before adopting the concept of relational aesthetics to the theory of play, the use and understanding of the term, "relational", was investigated in the play-related literature. A few references were found where authors used this term to describe the type of play known in the academic literature as “sensory-motor play”. Thus, relational play refers in this study to a type of play that facilitates the development of social competence in children through play equipment as a part of children's physical environment (see section 2.3.3).

Thirdly, a new conceptual design model of play equipment was developed which contributes to toy design for children with cerebral palsy and to inclusive design. This model defines the relationship between children with cerebral palsy, their social competence, play equipment and relational play as follows: play equipment encourages social interactions amongst children with cerebral palsy through relational play, which in turn helps them to practise social skills and thus to develop their social competence. Therefore, the purpose of such play equipment is to create the necessary conditions for embedding social skills, such as cooperation, turn-taking, helping, sharing and initiating. These skills cover the verbal and non-verbal social interactions for a group of children during relational play. The development of the conceptual design model was presented in section 2.4.1 of the literature review chapter and its further refinement in section 5.2 of the design chapter. The study found that the model is useful in designing children’s educational tools in the context of conductive education for children with cerebral palsy.

Fourthly, to design this specialist play equipment, design criteria were developed (see section 4.6.3). These criteria allow other designers to create play equipment for children with cerebral palsy in order to address the social development of these children. The design criteria were supplemented by more specific design recommendations which were formulated based on the findings from the data analysis (see section 4.6.4).

Fifthly, in regard to educational toy design for children with cerebral palsy, this study offers two practical examples of relational play equipment. These examples are the prototypes of Olly the Octopush for practising turn-taking and Hetty the Hexapush for practising cooperation.

7.4 Research limitations

Researching the topic of this study was a challenging and complex task, integrating features from the different areas of child-friendly design, inclusive design, toy design, sensory design, and ideas from sociology (models of disability), psychology (atypical development) and education (peer-related social competence). The study was informed by the social model of disability and stressed the significance of the social implications that children are faced with as the result of cerebral palsy. Design practice became an agent of change of the current situation. The findings suggest that relational peer-play, using purposely designed play equipment, can provide opportunities for children to make friends regardless of the physical challenges they experience during play.

While the findings are very promising, the research was a small-scale, qualitative study, which was carried out in a single specialist education institute (the National Institute of Conductive Education) with a small number of children, with their parents and conductors. The use of a small sample and qualitative methods was deemed most appropriate for this study because this approach allowed in-depth data to be explored and evaluated. This enabled collection of detailed information about the characteristics of play and social interactions of participating children with cerebral palsy and provided rich and in-depth data to inform the design development. It also allowed evaluation of the effectiveness of the design intervention to enable an understanding of the nature and extent to which qualitative changes in the children's social interactions and social competence were enabled through the play equipment. Because of the study's small scale and its reliance on the specific setting within a single institution, its findings may not be directly transferrable to other educational provisions (nurseries, nurseries specifically for disabled children, etc.) and a larger evaluation may be needed to confirm the findings across different settings and across a larger and more diverse sample of children.

Further, the play environment concept, Undersea Friends, that was developed for this study, was envisaged to consist of the three toys: Octopush Olly for practising turn-taking, Hexapush Hetty for practising cooperation and Larry Long Legs for practising sharing. Due to the scope of this research, only three social skills were chosen as examples to demonstrate how the main function of implementing the practicing of social skills into a design object could be achieved. While in reality most social skills are inter-connected and depend on each other, so the dominant skill designed into one toy will not be the only one which can be practised by playing with it. However, designing a fourth toy to allow children to practise 'helping' would have offered a more comprehensive perspective on enabling social competence. In fact, because of the time frame it was only possible to build prototypes of two of the toys: Olly and Hetty. Therefore, the evaluation results refer to these two toys individually and not to the whole play environment. Within a further study, developing the play environment consisting of the toys which address all social skills related to peer-related social competence would be a very useful area for continuing research.

In reviewing the methodology of this thesis, it is important to note that the subjects under the study were children, therefore, the adopted research design had to be child-friendly. Despite perceiving children as competent social actors with own perspectives and views, this study has not involved them as direct research participants. Instead, their views and experience were captured through conductors and parents who can partly represent the children's points of view, but these cannot compensate their own views. Semi-structured interviews and focus-group discussion with them were conducted to balance and validate the observations of children. These observations were used to understand the needs, social skills and engagement with toys of the children, as interviewing them would not bring forth the data needed for designing the prototypes. In future studies examining toy design for children with cerebral palsy, or with other conditions, research methodologies could be developed further to involve children themselves more directly. Research with more children's involvement can be developed if more time and resources are available. Finding more participatory methods with the adaptation to children's abilities might allow children to be involved in designing 'look' of the toys and might extend and deepen the findings.

This research revealed how children participated in relational play with the toys during either one, two or three play sessions (different for each child). Because of the time frame of the study, it was not possible to conduct a longitudinal evaluation in order to see how long it would be before the children needed more stimuli in order to engage with the toys, how do social skills change if the toys are used on a daily basis and for a longer time, also, how the toys need to be developed further as they grow and develop. Further research could therefore look at children's play with the toys on a more long-term basis, possibly by incorporating play sessions with then in a structured programme at NICE.

7.5 Recommendations for further research and practice

Future research could focus on designing a fourth toy to practise helping and building its prototype, together with the prototype of the third toy (Larry Long Legs for practising sharing), in order to test the Undersea Friends environment in its entirety and cover all the main social skills of peer-related social competence in children from 4 to 6 years of age. An evaluation of Undersea Friends on a larger scale and over a longer time period would allow exploration of whether children who play consistently with the toys develop better social skills and therefore are more successful and socially competent in the long term than similar children who do not play with them.

As this research was carried out in one specialist educational provision, further research in other educational provisions would be useful to corroborate the current findings.

Another potential for future studies could be concerned with the application of the research outcomes for developing play equipment for social development of children with disabilities other than cerebral palsy, for instance those with autism.

This study offers possibilities for further research for both scholars and practitioners in the field of design for health and well-being and other related areas. The conceptual design model of relational play equipment and the design criteria can be applied by scholars and practitioners in their own practice for creating play equipment for children with cerebral palsy.

DISSEMINATION OF THE RESEARCH

As part of the research development, presentations of research work have been made at four external conferences: the 3th International GamiFIN Conference 2019, Levi, Finland; the 8th ITRA (International Toy Research Association) Conference "Toys and Material Culture: Hybridisation, Design and Consumption", Paris, France; DRS2018 Conference, the University of Limerick, Ireland and Postgraduate Research Conference “Communication, Collaboration and Commitment”, the University of Worcester, and at internal conference: Annual Research Conference ARC 2017.

Publication: Borzenkova, G., Niedderer, K., Rozsahegyi, T. (2018) Designing play equipment for children with cerebral palsy: the context and design guidelines. Conference proceedings of the DRS2018: Design Research Society, University of Limerick, 25-28 June. Available from:

http://www.drs2018limerick.org/track/inclusive-design-inclusive-sig

This research has also been awarded DRS Student Research Award, ITRA Prize for Outstanding Toy Research, and was twice a winner at the Annual Research Poster Competition at the University of Wolverhampton, and the 3th International GamiFIN Conference 2019, Levi, Finland.

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APPENDIX A – Information sheet, consent form and questionnaire

Information sheet for the parent of the child with cerebral palsy

Designing play equipment for the development of social competence of early years children with cerebral palsy

You are being invited to take part in a research study. Please take time to read the following information carefully. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Your time and input is very much appreciated.

What is the purpose of the study?

This study is looking at designing play equipment that encourages peer-to-peer social interaction of children with cerebral palsy as part of developing their social competence. I am trying to develop a new model of play equipment that can engage children in child-object-child interactions during play sessions, and thereby to create a level playing field for these children that enable them to develop their social competences naturally.

Who is organizing the study?

This study is being conducted by Anna Borzenkova as part of her study for a PhD in Design under the guidance of Prof. Kristina Niedderer, Dr. Tunde Rozsahegyi and Prof. Dew Harrison at the University of Wolverhampton.

What would I be asked to do if I take part?

If you decide to take part, you will be asked to sign a consent form but you are still free to withdraw at any time up until data analysis without giving any reason. I would like to observe your child during play sessions in the National Institute of Conductive Education and other settings (nursery, private nursery, specialised nursery, reception class) where your child also attends. The purpose of this observation is to obtain a view of how individual children interact with other children and how they engage within play activities. You also will be asked to participate in an interview where you will be asked to share your observations regarding the social development of your child. A questionnaire survey can be used as an alternative to the interview should you prefer that option.

What will happen to my information if I take part?

Research data will include hand written notes of the observations of your child. I would also like to voice record the interview sessions. All data will be anonymised and all identifiers and potential identifiers removed. All computerised data will be password protected. Please be assured that only the researcher will have access to the data (Anna Borzenkova). Aspects of the data may be shared with my supervisors (Prof. Kristina Niedderer, Dr. Tunde Rozsahegyi, Prof. Dew Harrison). If you prefer your sessions not be recorded but would still like to take part in the study, please speak to the researcher about your preferences or if you have any questions or concerns.

What happens if I change my mind?

If at any time you want to stop the interview, or you decide at a later date that you want to withdraw from the research, you are free to do so without giving any reason.

What will happen to the results of the study?

The results will be written up and will form a part of the final PHD thesis. The results will also be written up and disseminated as an academic paper and related public materials. If you would like a copy of the results I will be happy to provide this for you.

What if I want more information about the study?

If you have any questions or require further information please contact Anna Borzenkova (researcher) or Prof. Kristina Niedderer (Director of the study):

Anna Borzenkova

Email: [e-mail address redacted]

Tel: [telephone number redacted]

Kristina Niedderer

Email: [e-mail address redacted]
Tel: [telephone number redacted]

Thank you for reading this. Please keep this sheet for your information.

Information sheet for the practitioner who are working with the child with cerebral palsy

Designing play equipment for the development of social competence of early years children with cerebral palsy

You are being invited to take part in a research study. Please take time to read the following information carefully. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Your time and input is very much appreciated.

What is the purpose of the study?

This study is looking at designing play equipment that encourages peer-to-peer social interaction of children with cerebral palsy as part of developing their social competence. I am trying to develop a new model of play equipment that can engage children in child-object-child interactions during play sessions, and thereby to create a level playing field for these children that enable them to develop their social competences naturally.

Who is organizing the study?

This study is being conducted by Anna Borzenkova as part of her study for a PhD in Design under the guidance of Prof. Kristina Niedderer, Dr. Tunde Rozsahegyi and Prof. Dew Harrison at the University of Wolverhampton.

What would I be asked to do if I take part?

If you decide to take part, you will be asked to sign a consent form but you are still free to withdraw at any time up until data analysis without giving any reason. I would like to observe the children you are working with during play sessions in the National Institute of Conductive Education and other settings (nursery, private nursery, specialised nursery, reception class) where these children also attend. The purpose of this observation is to obtain a view of how individual children interact with other children and how they engage within play activities. You also will be asked to participate in an interview where you will be asked to share your observations regarding the social development of the targeted children.

What will happen to my information if I take part?

Research data will include hand written notes of the observations of the targeted children. I would also like to voice record the interview sessions. All data will be anonymised and all identifiers and potential identifiers removed. All computerised data will be password protected. Please be assured that only the researcher will have access to the data (Anna Borzenkova). Aspects of the data may be shared with my supervisors (Prof. Kristina Niedderer, Dr. Tunde Rozsahegyi, Prof. Dew Harrison). If you prefer your sessions not be recorded but would still like to take part in the study, please speak to the researcher about your preferences or if you have any questions or concerns.

What happens if I change my mind?

If at any time you want to stop the interview, or you decide at a later date that you want to withdraw from the research, you are free to do so without giving any reason.

What will happen to the results of the study?

The results will be written up and will form a part of the final PHD thesis. The results will also be written up and disseminated as an academic paper and related public materials. If you would like a copy of the results I will be happy to provide this for you.

What if I want more information about the study?

If you have any questions or require further information please contact Anna Borzenkova (Researcher) or Prof. Kristina Niedderer (Director of the study):

Anna Borzenkova

Email: [e-mail address redacted]

Tel: [telephone number redacted]

Kristina Niedderer

Email: [e-mail address redacted]
Tel: [telephone number redacted]

Thank you for reading this. Please keep this sheet for your information.

Designing play equipment for the development of social competence of early years children with cerebral palsy

Consent form

To be signed by the parent of the child with cerebral palsy

I understand that I am asked to participate in the research "Designing play equipment for the development of social competence of early years children with cerebral palsy":

- I will be asked to take part in an interview session about my observations, perceptions and feelings regarding social competence of my child or questionnaire survey as an alternative.
- I will be asked to allow nonparticipant observations of my child in his/her course and play time at NICE and other educational/childcare provision where my child also attends.

By signing below, I indicate that:

- I confirm that I have read the information sheet and have had an opportunity to ask questions and any questions that I may have asked have been answered to my satisfaction.
- I understand that my answers will be anonymous, and I will not be identifiable in any report or publication. All data from observations will be anonymised and all identifiers and potential identifiers removed. Information I provide may be used in published study.
- I consent to the recording of my voice during the interview. I understand that all information will be anonymous. Please tick the box if you agree to the recording of your voice during interview sessions ☐.
- I understand that at any time, I am able to refuse to answer any questions without giving any reason.
- I understand that I am able to withdraw from the above study at any time without reason.

Please tick the box to agree to take part in this research:

☐ I agree for the observations of my child in his/her course and play time at NICE.

☐ I agree for the observations of my child in his/her course and play time at other educational/childcare provision where my child also attends.

☐ I agree for the interview sessions and questionnaire.

Signed ______________________

Date ________________________

Questionnaire about taking part in research about play equipment

I would be grateful if you could spend some time and complete this questionnaire.

My child's gender: male ☐ female ☐

My child's age: under 3 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 6+ ☐

Please indicate the days s/he attends to NICE:

Mondays ☐ Tuesdays ☐ Wednesdays ☐ Thursdays ☐ Fridays ☐

In which group? ______________________________

Are you planning for your child to attend NICE in the next academic year?

Yes ☐ No ☐ I have not decided yet ☐

Does my child attend other educational/childcare provision beside NICE (e.g. nursery, private nursery, specialised nursery, reception class, etc.): Yes ☐ No ☐

If yes, which one? (e.g. name of the provision, contact information) ______________

____

____

____

____

The best way to contact me:

☐ Phone: ______________________________

☐ Email: ______________________________

☐ In person: ______________________________

My name: ______________________________

My child's call name: ______________________________

Please include any additional information I should know: ______________

____

____

____

____

____

____

Thank you for completing this questionnaire.

APPENDIX B – Recording sheets for children's observations

Recording sheet template for data collection 1:

Child's name: _______________ Age: _____ Sex: _____ Date and time: ____________			
m	Activity record	Interaction record	Social code
2			
4			
6			
8			
10			
12			
14			
16			
18			
20			

The **activity record** includes what the child does in each two (three) minutes and materials he/she uses, without adding any interpretation.

The **interaction record** includes a child's social interaction or lack of it.

To help note down quickly what is done, it is helpful to use the following abbreviations:

OC – Observed child,
C – Other child,
A – Any adult (such as conductor, parent, etc.),
→ – Direction of an action (for example: speaks **to**, gives something **to**).

The **social code** helps to analyse observations in terms of social communication and interactions or their absence. The abbreviations of social code include the following:

S – Solitary play,
P – Parallel play,
G – Group play,
L – Looking at other children, but not involved in the activity,
I – Social interaction, but not a play,
W – Waiting (inactive).

In case of identifying group play or other social interactions with peers, the social skill(s) which target child demonstrated, should be also identified. The abbreviations of the social skills include the following:

CO – Cooperation,
TT - Taking turns,
SH – Sharing,
EX - Experience common emotions,
LI - Listening to others,
LO - Looking to others (eye contact),
TO - Touching the other,
SM - Smiling to/with others.

Recording sheet template for data collection 2:

Child's name: ________ Toy ____________ Age: _____ Sex: _____ Date: ________________			
Activity record	Interaction record	Indicators of engagement	Indicators of peer social interactions

Example of the completed recording sheets from children's observations 1:

Recording sheet

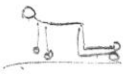
Child's name: C Age: 5 Sex: F Date and time: 18/10/17

m	Activity record	Interaction record	Social code
2	C was good at moving her legs left, right	Everybody are clapping => C is smiling when other children are clapping	C likes attention
4	C is trying to stand up then she is trying to stand in walkers then is trying to turn herself	Conductor encourages her A → C	
6	C is choosing from the subjects: English, Math, History she chose: English or Math?	A → C	
8	C is counting „Mi-mis" (3 mi-mis). Couldn't do that. C passed „mi-mis" to another child	Mi-mis C → C	pass „mi-mi" to the other child
10	Pretend play with mi-mis" „Does this Mi-mi is child C?"	A → C	pretend play
12	Chose which one is C and which one is not „Say three" C is trying to say	Vocalising to A	
14	Learning gestures Vegetables		learning gestures
16	food celebration		
18	Children are listening song about festival - harvest When C hear the words „vegetables, food, fruits, celebration etc." she should show corresponding gestures	C → A A → C	practising gestures
20	C tries hard „what part of the body do we use to eat?" C doesn't know	A → C	

„what do we use to smell?" C → A
C doesn't know.

Recording sheet (4)

Child's name: A Age: 5 Sex: F Date and time: 11/10/17

m	Activity record	Interaction record	Social code
2	lay → roll → up leg A is doing with physical help from conductor	A → C encouragements (verbal) physical help	
4	 A is trying to hold herself	encouragements from the conductor	
6	A needed to choose colours, then to compare pencils' lenght	A answered, but with the help of the conductor	
8	 A is trying to be in this position	with a little help from the conductor	
10	A is watching video on a tablet the task: • touch the head • touch the nose • wave „bye"	mainly concentrated, follows the instructions from the conductor	
12	A is listening to a story Sometimes she loose attention „Little Red Riding"		
14	A is trying to show „F" in her communication book to „say" - Fairytale	Child → Adult	
16	Another child touched her hand. A removed her hand to avoid touch	C → C	physical touch (avoided)
18	A is walking with  She is trying hard, but it is difficult for her.	the conductor encourages her	
20	A is sitting and looking around observing others	C → .	observing others

Example of the completed recording sheets from children's observations 2:

A- adult (conductor)
C - children
B- child B

Child's name: B Toy Olly Age: 5 Sex: F Date: 12/02/2019

Activity record	Interaction record	Indicators of engagement	Indicators of peer social interactions
B joined the group 5 min later (she has high temperature) B is observing how other C are playing with Olly	observing B → C		observing other C.
A asked C to present Olly to B. B is listening carefully and observing B looks focused	A → C C → B B listens observes	looking at Olly observing	listening to other C.
B doesn't touch the toy or try to play but follows the light and aware of the situation		observing Olly (exploring visually)	
light comes to her tent => she doesn't press on the tent, but noticed it			
B is following the light with her eyes and observes how C press on tent. light comes to her tent	B → C		
for 3rd time => B moved to show that she wants to press/touch the tentacle	B → A B → toy		
B has a lot of involuntary movements, tremors, weak arms => she needs physica help A helped B physically to	A → B		
press on tent => B is smiled and makes movement (excitement) B tries to touch fabric more (hard for her)		touching Olly's tent	
B touches tent by her feet (B has better control of her legs, than arms) smiles a lot A took of her socks =>		(pushing the button/tentacle) B. found own strategy to play	smiling
B can feel the fabric of Olly B smiles, looks excited	A → B C → B observes	stroking fabric of the toy	smiling to others
B follows the game (take turns)	B → C	smiling	turn taking
when light comes to her B vocalises with the song	B → toy	listening Olly's song vocalising	vocalising with others

4A. present
5C. present

Child's name: E Toy Hetty Age: 6 Sex: F Date: 7/02/2019

Activity record	Interaction record	Indicators of engagement	Indicators of peer social interactions
E (the only one who can "speak") Just saw Hetty "Very cool! It's magic" E smiles		looks at toy, comments	
Very curious Touched the tent. immediately Tent. lighted up E: "I can do it! I love it"	E → toy E → C,A	touches the tent, comments and shares her emotions	speaking to others
Looks very excited. Touches the tent. more times ⇒ smiles Observes others' reaction on her actions	E → C	touches,	observing C. reactions
E asked: "What is the name?" "Is it Octopus?"	E → A, me	curious, asks about Hetty	
Presses on the tent. to see light and hear sound. (doesn't understand how to cooperate) Excited and shares her emotions with others by smiling, looking at other C... Reward feedback (song + fountain + illumination) without underst. how	E → A,C	smiles	smiling to others, looking at others; smiling to and with other C.
Tries to "dance" with the song Press on tent. gently E press on tent with one hand (left) A encourages E to use her right hand	A → E	"dancing" with Hetty's song; use both hands	
E tries hard, smiles when succesfull Reward feedback again. E asked me "Would you like to try?" (to play)	E → me	smiles touches (presses)	
E guessed that for reward feedback all the C. should participate. E looks at C when C doesn't press on tent.	E + C	understands how to cooperate	cooperation
Hetty sings the song. E remembered some words ⇒ She sings with Hetty and other C vocalise	E + toy E + toy + C.	remembered words of the song; sings with Hetty	looking at others; singing with Hetty and C.
E is exploring the surface of the tent (it's easier to press at some parts of the tent)	E → toy	explores the tent	

APPENDIX C – Interview questions

Questions for parental interviews:

1. What does your child enjoy?
2. What does motivate your child?
3. Do you think it is necessary for your child to be among other children and why?
4. How often has you child the opportunity to be with/interact with other children?
5. Does your child show interest in other children (e.g. looking at, listening, smiling to other children, touching the others, etc.)?
6. What is your child's favourite game/play activity in educational/childcare provision (e.g. NICE, nursery, reception class, etc.)?
7. Does it involve any toy/play object? Which one?
8. What is your child's favourite game/play activity at home?
9. Does it involve any toy/play object? Which one?
10. How do you encourage your child to take part in other games/play activities at home?
11. Do you use any toy/play object for that?

12. What type of toys/play objects does your child play with?
13. What is the favourite toy of s/he?
14. How much time does s/he spend playing with this toy?
15. What makes her/him start playing?
16. What makes her/him stop playing?
17. Why do you think s/he likes this toy (e.g. it is sensory, colourful, simple enough, soft, etc.)?
18. What do you think your child learns most from the toy?
19. If your child plays with toys for developing social skills, what type of toys are these?
20. What are the most important characteristics are you looking at in toys?
21. What toy/play equipment do you want to have for your child?

22. How often has your child the opportunity to be with/interact with other children?
23. How s/he behaves?

Plays on his/her own
Plays near other children
Plays near other children using the same materials
Observes other children
Listens to other children
Smiles to other children
Touches other children
Imitates other children
Plays in group
Responds to interactions from other children (accepts toy, smiles, etc.)
Initiates interactions with other children
Joins in the activity with other children
Plays cooperatively with other children
Shares toys
Taking turns during simple play

24. What goals do you have for your child?
25. Please include any additional information I should know?

Questions for interviews with conductors:

1. What do you think about the toys in terms of their physical properties?
2. Are the toys physically suitable for children with cerebral palsy?
3. Did the children like the toys/ enjoy playing?
4. Do you think the toys are inclusive?
5. Do you think the toys are intuitive? Is it easy to understand how to play with Olly and Hetty?
6. Do you think the toys encourage interactions between children?
7. Do you think Olly encourages children to practise turn taking?
8. Do you think Hetty encourages children to practise cooperation?
9. Did you notice any other social skills which children practised during play sessions with the toys?
10. Did you notice anything new in children’s behaviour during the play?

APPENDIX D – Example of the interview transcript and coding

Interview with parent of Child I!

Date: 7.11.2017

Do you have other children?

Younger sister, yes.

That's great.

What does I! enjoy?

She is very typical 5 years old girl. She loves Disneyland, princesses, dressing up, make up. Very typical 5 years girl, yes

How important do you think for I! to be among other children and why?

It's really, really important, because she learns from other children and definitely it's great to be around with other children. We have really big family with children around. We have fourteen nephews and nieces, so she is always surrounded by children.

How does I! usually behave? I mean how does she interact with other children? Does she initiate contacts or mostly observe other children?

She very much loves to do everything and anything, and want to be a part of everything.

If you are trumpeting, she wants to be trumpeting too.

As she becomes bigger now, she has more physical damages.

She is quite happy to be among other children.

She wants to do things, but it's not as easy as it might seem to be.

But she definitely wants to be involved in everything and do everything.

So, she tries different things, not just observes. Yes, she wants to be doing it, definitely.

What is I!'s favourite game/play activity?

I don't know. Um… dressing up, doing make up, some art, making things…

She's very typical… just anything… dolls, Barbie … um

Do you know I!'s favourite play activity here, at NICE?

No, there are not many. I think when she is physically standing, doing walking activities, she is very proud of herself.

It's very hard to keep busy every child. She is not has a seat and just watches. She definitely has to be occupied.

Do you motivate her to do something? Encourage her?

She shows interest in everything.

So, you don't need to give additional motivation?

No, no. she wants to do everything, just physically. Apparently, she does what she wants to do.

Does it difficult for I! to concentrate on certain activity?

No, she hasn't got any developmental delay. Just body doesn't work for her. She doesn't need encouragement.

Do you have a lot of toys? I mean, does I! like playing with toys?

Yes, we have a big massive of toys. But majority of them she can't use to play herself, physically.

She needs assistance by adults.

She has a scooter, which she can't go on, but she wants to. We had to buy it as her sister has.

It's very expensive to buy special toys for her. She wants everything that her sister has.

Does she have the favourite one?

Anything connected with Disney, Disneyland princesses. She loves Disneyland and she wants to go to Disneyland.

What are the most important characteristics are you looking at in toys?

Anything that can make her feels independent.

If I am busy cooking in the kitchen and her sister is busy playing, and she just wants to play and she needs help, and just says "mum, can you help me playing?", I need to stop what I'm doing to physically play with her.

Just anything that she can access and can do by herself.

Her four limbs are affected. Physically it's really hard to find toys for I! which are appropriate physically.

Do you think you have any toy/toys for social development?

It's quite difficult. Pretend play. She has pretend shop which she plays with her sister.

Lots of play activities for pretend play: doctors, nurses, some cooking, and lots of other things.

Does I! find it difficult to interact with new children?

Not with children. She's absolutely fine with children. Disabilities, age, anything, she interacts with any child.

But adults um, she struggles with adults. She loves children.

She feels confused when child suddenly just start staring at her. She tries smiling to start interaction with them, but she is fine when they are talking to her. She absolutely loves kids.

I! was very antisocial. You couldn't look at her or talk to her before. She walked long, long way.

She is fine here, but she is struggling in other school.

She doesn't have a peer group at school.

So we talk about mainstream school, so it's a big goal, really, - mainstream school.

So, now she is attending NICE and what about other setting?

She is at NICE one day a week and she goes into special school four days a week. But there are not many education of physical or social…um… she is in a classroom with children who have a lot of …um… more… autism, spectrum disorders. She has only physical disabilities. I mean, the whole school covers almost all disabilities, but the actual class is with lots of children with walkers, talkers and…um…

So, you mean there are children with cognitive delays, isn't it?

Yes. It's about learning colours, numbers, learning alphabet and it's more sensory based.

She hasn't have peer group. There are more interactions with adults at school, rather than interactions with children, with peer group.

(8:50) There are some people who came to assess them, but in mainstream it's more … about

It's good, but it's scary for I!, it's not your home, isn't it?

Yes, it's always hard to start something new, I think.

But it can be excited for I!.

I think she will be fine. So that is the goal to go to mainstream school. I hope she will be happy with it and will be progressing.

What toy/play equipment do you want to have for I!? It can be something existent or some features, characteristics which you want to see in toys, but can't find.

Even something that can sticks to something, because she can grasp and can do some other things. Anything that would stand and doesn't move, or something that I don't need constantly to hold. Anything that can stay would be really good.

Even easier art & craft things - paint brushes which maybe have a wrist strap. Really simple things can make a great difference. Pencils which are easy to hold, glue sticks, anything that is easier to hold. Especially things which make her frustrated, which she can't give a go and she keeps struggling.

So, it can be just usual toy, but more suitable, isn't it?

She has a little sister who has a scooter and she wants a scooter. We tried to explain to her that it's quite hard to use for her scooter, but she wants it and we say "Ok, ok". Dad tries to adapt it to her. So, even a scooter that allows her physically to stand and hold. Her dad has made different creations for her at home.

We saw some tray for special needs, but it's really expensive. Something she can do by herself, so she can pedal it by herself. Yes, they are so expensive, really expensive.

And it would be great to have easier access to outdoor activities. For example, slidedown. We have to sit on big sledge and strap her on it. Something that is so simple but can make a huge difference.

Thematic analysis of the interviews

Interactions							
Family				Familiar people		Strangers	
Siblings	Parents	Relatives		Peers (friends, schoolmates, etc.)	Adults (teachers, practitioners, etc.)	Children	Adults
		Children	Adults				
she tries different things, not just observes She wants everything that her sister has Pretend play. She has pretend shop which she plays with her sister. Lots of play activities for pretend play.	If you are trumpeting, she wants to be trumpeting too If I am busy cooking in the kitchen and her sister is busy playing, and she just wants to play and she needs help, and just says "mum, can you help me playing?"	big family with children around She is quite happy to be among other children We have fourteen nephews and nieces, so she is always surrounded by children loves to do everything and anything, and want to be a part of everything She was very antisocial. You couldn't look at her or talk to her before. She walked long, long way.	But adults um, she struggles with adults She was very antisocial. You couldn't look at her or talk to her before. She walked long, long way.	learns from other children definitely it's great to be around with other children She is quite happy to be among other children She's absolutely fine with children. Disabilities, age, anything, she interacts with any child. She feels confused when child suddenly just start staring at her. She tries smiling to start interaction with them, but she is fine when they are talking to her. She was very antisocial. You couldn't look at her or talk to her before. She walked long, long way. She absolutely loves kids. She is fine here (at NICE), but she is struggling in other school She doesn't have a peer group at school. There are more interactions with adults at	But adults um, she struggles with adults She was very antisocial. You couldn't look at her or talk to her before. She walked long, long way. She is fine here (at NICE) There are more interactions with adults at school, rather than interactions with children, with peer group (special school).	learns from other children definitely it's great to be around with other children She's absolutely fine with children. Disabilities, age, anything, she interacts with any child. She feels confused when child suddenly just start staring at her. She absolutely loves kids. She was very antisocial. You couldn't look at her or talk to her before. She walked long, long way. but in mainstream it's more … about It's good, but it's scary for Isabelle, it's not your home, isn't it? I think she will be fine. So that is the goal to go to	But adults um, she struggles with adults She was very antisocial. You couldn't look at her or talk to her before. She walked long, long way. but in mainstream it's more … about It's good, but it's scary for Isabelle, it's not your home, isn't it? I think she will be fine. So that is the goal to go to mainstream school. I hope she will be happy with it and will be progressing.

				school, rather than interactions with children, with peer group (special school).		mainstream school. I hope she will be happy with it and will be progressing.	
	wants us to read books with her, baking, cooking now she trying to use gestures to express what she wants to do		Matching games with my dad, so her granddad When my mom comes she will play something different. It depends who is playing with her	at Mainstream School she likes peer lessons loves interacting with other children as well She kind of gets along in her mainstream setting with children and parents she loves being around other children I think probably problems arise when we get into situations where children want familiarize with her She wants to do the same She sometimes may not initiate play with others, but she might want them to come to her	She kind of gets along in her mainstream setting with children and parents		
Twin sister. They look after each other	Doing craft with her mom and sister. Making things			She likes to be involved. she can be self-confident as well		She is not afraid to approach. She can easily ask "what is your name". She is not afraid. Sometimes she can be shy for 2-5 mins and then best friends.	
	He asks for a help, but he wants to do what he wants			He wants to meet new friends Before he was like, he was really scared of other	He is able to say Yes or No and he uses his communication book	Before he was like, he was really scared of other children because he can't actually move his	very scary, very-very scary. And new people, not only children, but new adults as

	he was calling me "mum" and he showed his hands "Come and help me"			children because he can't actually move his hands to show "stop", "don't come" At school he has his friends. He tries to talk He observes. Yes, he is observer. He is sitting and observing other children. He is able to say Yes or No and he uses his communication book He has a friend D. The boy is with the same diagnose as E, but he is not on the same level as E, a lower one. And E, he is chatting with him, telling him, explaining… It took a lot of time for him to open.		hands to show "stop", "don't come" very scary, very-very scary. And new people, not only children He observes. Yes, he is observer. He doesn't like when somebody is touching him. Somebody, whom he doesn't know and who doesn't know him. Friends are OK now, but not a new people. he doesn't want to open to new people The one thing that can stop E are kids, the new kids, who are coming. And he want just say "I don't want to play, I don't want nothing, just stop it".	well He doesn't like when somebody is touching him. Somebody, whom he doesn't know and who doesn't know him. Friends are OK now, but not a new people. he doesn't want to open to new people Communication is important, but he just doesn't want to communicate with the new ones
Her sisters are like her world like her older sister is very caring and will look after her She never plays by herself like with a dolls or anything like that	She enjoys playing games that involve other people. So shared games rather than on her own.			She likes things that children play with her or against her. She enjoys playing games that involve other people. So shared games rather than on her own. she learns from other children		She is very sociable	She is very sociable

her level of communication is very different between her friends and her sisters				They tried to do things for her because they don't quite realize that she is just the same as them There is quite a big gap in communications between what she's going to do and what she does. she'll show you what she wants to play She wants the children to be interested in her			

Play equipment			
Desired toys, toys' characteristics, features, properties, etc.	Problems (what are missed)	Already have	Favourite toys (why)
Anything that can make her feels independent. Just anything that she can access and can do by herself. physically appropriate Even something that can sticks to something, Anything that would stand and doesn't move, or something that I don't need constantly to hold Anything that can stay would be really good. Even easier art & craft things - paint brushes which maybe have a wrist strap. Pencils which are easy to hold, glue sticks, anything that is easier to hold. even a scooter that allows her physically to stand and hold We saw some tray for special needs, but it's really expensive. Something she can do by herself, so she can pedal it by herself.	We have a big massive of toys. But majority of them she can't use to play herself, physically. She needs assistance by adults. She has a scooter, which she can't go on, but she wants to. We had to buy it as her sister has. It's very expensive to buy special toys for her Physically it's really hard to find toys for her which are appropriate physically Especially things which make her frustrated, which she can't give a go and she keeps struggling. it would be great to have easier access to outdoor activities.	Trumpet dolls, Barbie scooter pretend shop	Disneyland heroes, princesses. Anything connected with Disney.
it would be some which is easy to reach something which is a larger, for example tea cups set something that she can manage she needs to develop her fine motor skills, so we also try and get things that she could use to play with Colourful, Developmental, Something that she can interact with, but not get frustrated. It would be cool if there are more toys, like dolls or bears	It is simply too small so I guess something which is a larger, for example tea cups set So if there are too many little pieces like Lego, she will probably be alright firstly, but afterwards she will be frustrated	communication electronic device soft toys, blocs, jigsaws, writing staff she likes cause and effect toys	I-pods Bears books

which reflecting more diversity. Books Books that focused on emotions. Trying to get her to identify them.			
easy holding Maybe bigger toys I don't know maybe interactive toy that guide Toy may have a screen inside of it and can be a tablet to write to type. Learning toys drawing with fingers. showing videos which say to push something or how to tie shoelaces		lightbox	computer
We are looking for a …mmm…add voice. Something like piano, where he needs just to press to hear voice			Peppa Pig a swing he loves piano, he loves bricks and loves to build a castle he loves games, like a Chinese game a balance game, when he needs to make …mmm…a balance
Not too many little pieces Nice and bright and colourful, also texture not always plastic, but wooden things that could encourage her to do things		play kitchen dolls and drams but with her sisters	

Activities		
Play activities		Leisure, sports, etc.
Physical play	Pretend play	
She loves Disneyland, princesses, dressing up, make up Trumpeting Physically standing, doing walking activities She wants to do everything, just physically	Lots of play activities for pretend play: doctors, nurses, some cooking, and lots of other things	Dressing up, doing make up, some art, making things Learning colours, numbers, learning alphabet
She loves lots of physical things despite her limitations Favourite activity…Some physical activities	She quite likes role play. She feed them and we can crop vegetables. She says good night to them when we have to go into bed	She loves lots of physical things despite her limitations Wants us to read books with her, baking, cooking She wants to be more active, so now she wants to walk around, but before she sits quite passive Matching games
	Imaginary games	Computer games Reading Doing craft with her mom and sister. Making things She comes here for physical help for mobility of fine muscle movements
Play like a dogs or cats Crawling Kicking the ball towards A balance game, when he needs to make …mmm…a balance		Only wants to watch Peppa Pig Playing on the computer To learn alphabets, to read a story or data listen and he needs to answer questions. So he loves it. He can play for two-three hours. A swing He loves piano, He loves bricks and loves to build a castle He loves games, like a Chinese game Like a cards game. We have 5 or 6 cards with pictures and my husband says some word, like "a cat", so E needs to find the right card with a cat.

		We practice the alphabet, the voice, Even when we are in the kitchen, and we are making a dinner, he helps me with everything. Of course it only takes hours longer. He is cutting a carrot, he is cutting a meal
She enjoys activities that are very physical So climbing	play kitchen	Outdoor things. Obviously they're not all accessible Swings She enjoys playing games that involve other people. So shared games rather than on her own. She never plays by herself like with a dolls or anything like that She likes things that children play with her or against her. She really enjoys craft ideas. Sort of painting Play matching activities like matching pairs on a tablet swimming lessons

Cerebral palsy
As she becomes bigger now, she has more physical damages. She wants to do things, but it's not as easy as it might seem to be. Her four limbs are affected She hasn't got any developmental delay. Just body doesn't work for her. But majority of them she can't use to play herself, physically. She needs assistance by adults. She was very antisocial She has only physical disabilities She can grasp and can do some other things.
it's a bit difficult for her to do things just because level of dexterity communication is a bit hard she is probably not the same stage as other children And she with her dysfunction is slightly delayed, developmentally delayed She's just a bit further behind. She has communication difficulties and it's hard for her to cope with behaviour
It's hard for her to do this, to do fine movements
Before, you know, it was very, very hard to bring him here to start work. He has been crying about two-three months So he is able to move his hands. Now he is able to open his hands, to grab something. Before he wasn't able to move his hands, so it was really, really hard. When he wanted to press on something, he had a problem. Now he is Ok, but before. He needs to stand. He is able now ... not independently… I mean to stand physically, but he can hold and stand. he has a muscle tough. So it's really hard to make any voice. he is moving his hands, but he doesn't have really good control.
walking with sticks She doesn't speak. So it's an act or gesture

	won't play He loves when he can do it. "Oh, yes, I can do it. I can make some different voices." Every day we teach him something and he tries it. And there is nothing to stop him. He asks for a help, but he wants to do what he wants. It's not like "I can't manage it". So, he will call someone "Come on, help me to do that" He wants to do everything even if he knows he can't, he wants to. He can do, you need just to show him.	
	I did it myself first. She wants to have a go rewarding her for doing it at the end Her sisters are very encouraging and they can go to nearly anything. They can persuade her to do it no problem at all.	

Feelings	Motivation	Goals, expectations
much loves to do she definitely wants to be involved I think when she is physically standing, doing walking activities, she is very proud of herself. She is not has a seat and just watches. She definitely has to be occupied She shows interest in everything She has a scooter, which she can't go on, but she wants to. We had to buy it as her sister has. Especially things which make her frustrated, which she can't give a go and she keeps struggling	She doesn't need encouragement.	
she loves lots of physical things despite her limitations sometimes even if she's struggling, she wants to do, but sometimes she is just saying "no" quick he has favourite bear and gets upset when she wants to hold that bear	sometimes even if she's struggling, she wants to do, but sometimes she is just saying "no" quick She's got quite good concentration when she enjoying something But, we are trying to take a step back and allow her develop her own strategies to get children	I just want for her to be happy, to be inclusive to society, not exclusive. I would like her to develop … toileting, …communication I think she has a lot of things which are going on in her head, so I just want for her to express… I wish she will develop over time skills to express more what she is thinking about
	Sometimes she has a Focus and she enjoys it and if she can't do it she can be easily annoyed to say ummm I don't want to do that say for example - lets to do stuff together	to make her independent to use hands more sitting independently
Before he was like, he was really scared of other children because he can't actually move his hands to show "stop", "don't come" Now he is more confident	I told him, that he is a soldier and he needs to be like big brother, he needs to show his little brother When a little one starts crawling, Eryk wants to do this as well The little one motivates him to roar or something. We look what are interesting for him, because otherwise he	I want him to be independent, as much as he can. We want him to open

APPENDIX E – Third-party materials permission

Page No	Type of work	Title of work	Details and Source of work	Copyright holder and contact details	Date of contact	I have permission
60	image	Gobug interactive toy.	http://www.core77.com/posts/19262/autism-connects-gobug-interactive-toy-19262	Coroflot website	4/12/2017	Yes
61	image	Toy for touch created for children with autism.	http://www.divms.uiowa.edu/~hourcade/idc2012-specialneeds/dsouza.pdf	Dsouza, A.J., Barretto, M. & Raman, V. (2019). Uncommon Sense: Interactive Sensory toys that encourage Social Interaction among children with Autism. http://www.divms.uiowa.edu/~hourcade/idc2012-specialneeds/dsouza.pdf	4/10/2019	Yes
62	image	Wearable device Enhanced Touch	http://dl.acm.org/citation.cfm?id=2858439	Iida, K., Suzuki, K., Hachisu, T. (2016). EnhancedTouch: A Smart Bracelet for Enhancing Human-Human Physical Touch. Conference on Human Factors in Computing Systems CHI, California, USA, pp. 1282-1293. http://dl.acm.org/citation.cfm?id=2858439	4/11/2017	Yes
66	image	Montreal's Musical Swings	https://www.mtl.org/en/what-to-do/festivals-and-events/21-balancoires-montreal	JoDee Allen jodee@dailytlj.com	23/10/2017	Yes
67	image	Seesaw for children with cerebral palsy	http://www.coroflot.com/kerenrelin/design-for-children	Keren Chernyshev Facebook page	28/10/2017	Yes
238	photos	Playing with Olly and Hetty	Two photos shared by the conductors from NICE	The National Institute of Conductive Education, https://conductive-education.org.uk/	7/06/2019	Yes