

# STIMULATING ENGAGEMENT IN THERAPEUTIC ACTIVITIES FOR NEURODIVERGENT CHILDREN THROUGH A ROBOTIC BALL.

## Appendixes.

# Appendix 1: Project Brief

DESIGN  
FOR our  
future

TU Delft

IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

**STUDENT DATA & MASTER PROGRAMME**  
Complete all fields and indicate which master(s) you are in

Family name

Kurt

Initials

KK

Given name

Kumsal

Student number

IDE master(s)

IPD ☐ Dfi ☒ SPD ☐

2<sup>nd</sup> non-IDE master

Individual programme  
(date of approval)

Medisign

HPM

**SUPERVISORY TEAM**  
Fill in the required information of supervisory team members. If applicable, company mentor is added as 2<sup>nd</sup> mentor

Chair

Marco Rozendaal

dept./section

HCD

mentor

Eda Karaosmanoğlu

dept./section

HCD

2<sup>nd</sup> mentor

client:

city:

Delft

country:

Netherlands

Optional  
Comments

Eda Karaosmanoğlu is a PhD candidate, part of Convergence (TUD-EMC-EUR). Eda has done IPD in our Faculty, is now formally hosted at Erasmus University and also based at the ID-Studiolab. Mathieu Gielen is as an advisor for his specific expertise toward Convergence.

Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.

Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.

2<sup>nd</sup> mentor only applies when a client is involved.

**APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF** -> to be filled in by the Chair of the supervisory team

Sign for approval (Chair)

Name

Marco Rozendaal

Date

4 Mar 2024

Signature

**CHECK ON STUDY PROGRESS**  
To be filled in by SSC E&SA (Shared Service Centre, Education & Student Affairs), after approval of the project brief by the chair. The study progress will be checked for a 2<sup>nd</sup> time just before the green light meeting.

Master electives no. of EC accumulated in total

EC

Of which, taking conditional requirements into account, can be part of the exam programme

EC

★

YES

all 1<sup>st</sup> year master courses passed

NO

missing 1<sup>st</sup> year courses

Comments:

Sign for approval (SSC E&SA)

Name

Robin den Braber

Date

11 mrt 2024

Signature

Robin den Braber

Digitaal ondertekend door Robin den Braber  
Datum: 2024.03.11 08:31:32 +01'00'

**APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM** -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team comply with regulations?

YES

★

Supervisory Team approved

NO

Supervisory Team not approved

Comments:

Based on study progress, students is ...

★

ALLOWED to start the graduation project

NOT allowed to start the graduation project

Comments:

Sign for approval (BoEx)

Name

Monique von Morgen

Date

20 Mar 2024

Signature

Monique von Morgen

Digitaal signed by Monique von Morgen  
Date: 2024.03.20 02:04:07 +01'00'

Name student
Kumsal Kurt

Student number
5,502,713

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

Project title
Stimulating Social Interaction for Children with Special Needs Through Technology and Play

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

### Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

Children with developmental disabilities, including autism, often face challenges in social interaction and inclusion within educational settings. These children may struggle to form relationships with their peers and may experience feelings of exclusion in social environments, like schools. Social inclusivity is important for these children as it directly impacts their overall wellbeing.

Fizzy, an interactive robotic ball, designed (in a former PhD project and currently under continued development in another PhD project) to facilitate physical movement and play in hospital context, has the potential to address some of the challenges faced by children with autism in terms of social interaction and inclusion.

This project aims to explore how can embedding of Fizzy into classroom activities, create engaging and inclusive learning experiences that promote social interaction and cooperation among children with diverse needs and abilities. Fizzy can serve as stimulating agent to encourage peer to peer, teacher-children interactions, collaborative play and social engagement.

Limitations:The success of fuzzy in stimulating inclusivity and diversity for children with special needs/disabilities may depend on factors such as teacher training, support and willingness to integrate new technologies into classroom practices.

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introduction (continued): space for images

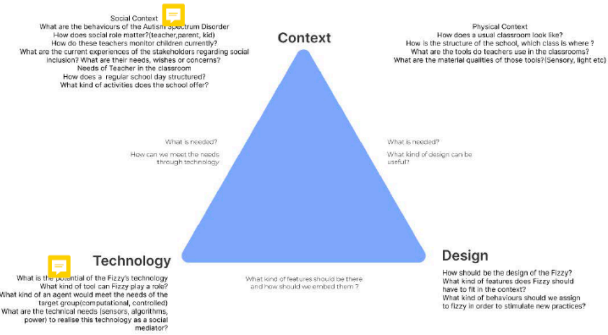


image / figure 1 RTD method for the project

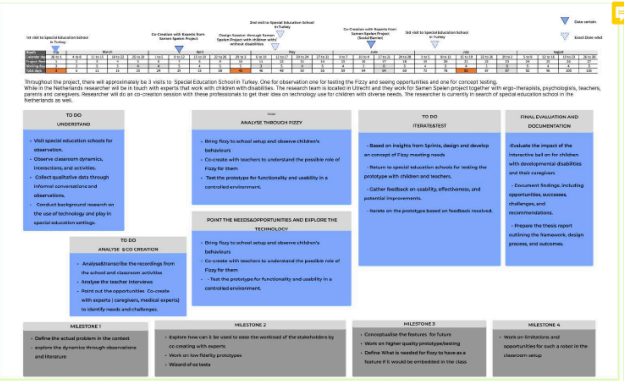
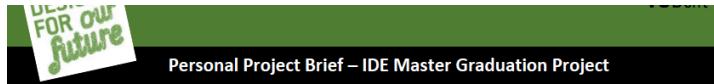


image / figure 2 Important dates and planning

# Appendix 1: Project Brief



## Personal Project Brief – IDE Master Graduation Project

### Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice. (max 200 words)

Children with developmental disabilities requires special support to continue their education and daily activities, involving interaction with teachers and peers who have diverse needs. That starts by understanding the needs of children as well as the caregivers. Embedding technology and play into classroom environments could introduce new practices for supporting these children socially. This project aims to understand the potential of a spherical robot ball, Fizzy to relieve some of the workload of the caregivers and examine how the teacher-child or child-child relationships might evolve with the introduction of an socially embedded robot. The findings can contribute to a deeper understanding of the role of technology in early childhood education and provide insights for educators seeking to create equitable, fun, inclusive, learning environments for all children.

### Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Investigate how the use of technology, specifically through a robot ball Fizzy, in classroom environments, could make an impact on social inclusion and diversity for children with developmental disabilities by stimulating new practices for teachers/ peers/ caregivers.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

There are 3 main topic of interest in the project to explore ; the context, the technology and the design. This will enable researcher to discover the context, build upon what is currently there and make suggestions of the use of the robotic ball fizzy, in special ducation setups. (See figure 1)

In the project, research through design approach together with sprint models will be used to foster practices. There are 2 stakeholders in the project, one in Turkey and one in the Netherlands. Special education school in Turkey will be the main point for observation, testing and concept evaluation of the Fizzy with their wide range of special needed students and expert teachers including 1 to 1, Sports, Ergotherapy experts. In the Netherlands experts (parents, teachers, psychologists, ergotherapists) from the Samen Spelen project will provide their guidance and previous work on inclusive play for children with and without disabilities. Fostering for new practices for those children and their caregivers is planned to be achieved by collaborations, co-creation sessions, tests, observations with experts, children, parents and schools. (see figure 2)

### Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting**, **mid-term evaluation meeting**, **green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).

Make sure to attach the full plan to this project brief.  
The four key moment dates must be filled in below

Kick off meeting 28 Feb 2024

Mid-term evaluation 30 Apr 2024

Green light meeting 17 Jul 2024

Graduation ceremony 23 Aug 2024

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	✓
For how many project weeks	26
Number of project days per week	4,5

Comments:

### Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five. (200 words max)

I have been interested in using design as a tool to enable wellbeing for vulnerable groups, especially for children. I chose children as a target group because their way of thinking, exploring the world, the way they play and interact with the surroundings are something that inspires me a lot. For me design is not only problem solving but also altering the interactions in a way that it can create a change. It is a process of creating a meaning and this meaning-giving becomes more important when it comes to the vulnerable groups. I am interested in the intersection of play, technology and well-being and I believe my project will enable me to explore the commonalities and patterns of each individual term as well as the intersections of these terms. I want to use design and technology as a tool to enable wellbeing for children with special needs. Designing for children and play is a topic that I have been deeply committed for, not only for my graduation but also for my career. Designing for children means that it is not the outcome that we design but to evoke the intuition and the process of inviting them to be in the trying and exploring mindset. I took two of the Mathieu Gielen's courses about children (design for children's play and co-creation with children), that fueled my enthusiasm to continue with this topic for my graduation. I will be working on diversity and inclusion in classroom environments for children with developmental disorders, like autism. I have no experience with designing for people with special needs but with my project I would like to gain a deeper understanding of how design and technology can create valuable change for this group by improving my understanding of terms; play design, objects with behaviours, activity theory, acting with technology and project management.



# Appendix 2: Interaction Patterns

	Interaction Patterns	When	Therapeutic Meaning	Perceived Meaning by Children
I.D.1	<b>Comes from an invisible area dedicated to it towards the activity area</b>	Initial introduction, mediating the therapist and the child	Eye Gaze; Joint Attention; Mediating the Activity	Initial Introduction "It came"
I.D.2	<b>Rolls towards, around the child and pause</b>	Initial introduction or when the child rejects to collaborate;	Initial introduction	"What is that?" "It moves" "A ball" "woow"
I.D.3	<b>Roll Towards(to teacher)</b>	The therapists calls Fizzy	Doing Instructions;Positive Reinforcer	Fizzy is listening to the introductions. "Come fizi" "Fiz go"
I.D.4	<b>Goes in a defined route(in front of the child)</b>	Modelling an activity	Visual Reinforcer;In motion together;Modelling Kinesthetic Behaviours;Motor Skills	Follows fizzy's route,When Fizzy does it wrong says"it did it wrong" and laughs at it
I.D.5	<b>Goes to its place in the classroom, turns its lights off and stays still</b>	It is turn for the child to perform tasks, does not respond to what the child says	Turn Taking; Pretended Play(characterising the ball);	"Fizzy is watching us w-right?"; "Fizzy wait for me"; "Fizzy will you also do the parkour?"; "Do it Fizzy, Do it Fizzy";
I.D.6	<b>Rolls around without an identifiable pattern</b>	In sport and ergotherapy session	Free Play;Hand Eye coordination; In motion Together, Joint Attention;Joint Engagement;Basic Movement Skills;Gross motor Skills	"I will catch you fizzy" "It is fast"
I.D.7	<b>Rolls towards, around the child, comes and goes based on the instructions</b>	To show what is fizzy and what it does ;The child engages with the activity, as a reward		Sits on the ground and gives commands to Fizzy, laugh"Come, play!" "Fizzy come" "Come fizi" "Fiz go" "Ball come on come" "Come Fizzy"; "Go Fizzy"
I.D.8	<b>Comes to the eye sight; stops;Rolls on its own axis;right and left</b>	Celebrates an achievement of the child	Joint Engagement;Shared enjoyment;Success and Team Play	A friend to share the joy with; Looking for reassurance; Looks at fizzy, caresses it and claps to the therapist
I.D.9	<b>Rolls after(teacher)</b>	Switching an activity	Eye Gaze; Joint Attention	Eye gazing towards Fizzy and goes to where fizzy is
I.D.10	<b>Not Responsive: Stays Still(inanimate)</b>	The child rejects listening what the teacher says and show interest in Fizzy	Negative Punishment;Classroom Rules	Feeling ashamed when child's resistance is announced to fizzy by the teacher(Fizzy, C1 is not following the instructions) and this enables the child to collaborate with the therapist again
I.D.11	<b>Rolls away from the Subject</b>	Perceived Threats, Unwanted Interaction, Guidance coming from the wrong source		"Where are you going fizzy"
I.D.12	<b>Rolls back to the subject when being kicked</b>	Being Kicked		Wants to be played with
I.D.13	<b>Goes to its place in the classroom, turns its lights off and stays still</b>	It is turn for the child to perform tasks, does not respond to what the child says	Turn Taking; Pretended Play(characterising the ball);	"Fizzy is watching us w-right?"; "Fizzy wait for me"; "Fizzy will you also do the parkour?"; "Do it Fizzy, Do it Fizzy";
I.D.14	<b>Rolls around ; Not reactive to commands</b>	It is disobedient to the instruction of the teacher;to test context blindness of the child and to stimulate fair treatment to students and fizzy	Following the Context;Fair Treatment;	"It does not wait! "
I.D.15	<b>Rolls towards (to other objects)</b>	To show where to go when the child is distracted	Motor Skills;Physical development	
I.D.16	<b>Rolls around without an identifiable pattern while turning on and</b>	In ergotherapy sessions to stimulate sensory integration	Gross Motor Skills;Hand Eye Coordination; Sensory Integration;	Running game; Hide and Seek "I see it" "I caught it" "where is it"

	<b>off its colors in a dark room</b>		Active Task Engagement Following the context; Joint Engagement;Free Play	
I.D.17	<b>Goes in a defined route(in front of the child)</b>	Modelling an activity	Visual Reinforcer;In motion together;Modelling Kinesthetic Behaviours;Motor Skills	Follows fizzy's route,When Fizzy does it wrong says"it did it wrong" and laughs at it
I.D.18	<b>Goes in a defined route</b>	Modelling an activity	Visual Reinforcer;Modelling Kinesthetic Behaviours; Turn taking; Active Task Engagement; Self Control(Movement)	Eye Gaze, follows where fizzy goes. Smiles, celebrates when it scores"Yeeey, you won" and claps to the teacher.
I.D.19	<b>Comes from an invisible area dedicated to it towards the activity area</b>	Initial introduction, mediating the therapist and the child	Eye Gaze; Joint Attention; Mediating the Activity	Initial Introduction "It came"
I.D.20	<b>Comes from its dedicated area towards to tehrapist</b>	When it is fizzy's turn	Turn Taking	
I.D.21	<b>Comes to the eye sight; stops;Rolls on its own axis;right and left</b>	Celebrates an achievement of the child	Joint Engagement;Shared enjoyment;Success and Team Play	A friend to share the joy with; Looking for reassurance; Looks at fizzy, caresses it and claps to the therapist
I.D.22	<b>Leaves the activity area</b>	The class is over	Activity Switching; Transition(Starting,pursuing and Finishing an Activity); Pretended Play(characterising the ball)	"Go home Ball" "Bye Bye ball" "Fizzy goes to its mom"
I.D.23	<b>Stays still;Changes Colour</b>	It has been played multiple times already in different ways and it becomes part of the game;rather than the main actor or the mediator of the interaction	Doing Instructions;Verbal Abilities; Communicative Speech;Cognitive Development(Color);Multi step Directions;Receptive Language	The color of Fizzy acts as an indicator to put and blow pompom on a surface in the same color e.g.:Choosing a pompom that matches with fizzy's colour and blowing it out from a high surface
I.D.24	<b>Rolls towards to other Therapeutic objects while changing colour</b>	It guides the established rules of the activity		
I.D.25	<b>Rolls back and forth while changing colours</b>	It guides the activity		
I.D.26	<b>Rolls in between the child and the therapist while changing its colours to which colour they say</b>	Takes guilENCE		
I.D.27	<b>Stays still;Emits "Yuppi" sound</b>		Success and Team Play	Imitates Fizzy's sound
I.D.28	<b>Being Taken Away by the therapist</b>	Does not pursue on the task but shows attention to Fizzy	Negative Punishment;Reasoning; Cause and Effect;Classroom Rules	Punishment "Don't take Fizzy, I will do it"

# Appendix 3: Consent Forms

## Informed Consent Form FOR PARENTS

Participant (full name): .....

Parent of the participant (full name): .....

Conducting person (full name): Kumsal Kurt

Please read the text below carefully and ask the conducting person about anything you do not understand or would like to know.

### What is the purpose of this study?

Hello, I'm Kumsal Kurt, after graduating from Özyeğin University, Department of Industrial Design, I am currently doing my master's degree in interaction design at TU Delft in the Netherlands. For my master's thesis, I am doing a study on neurodivergent children and their social needs. My target audience is neurodivergent such as children on the autism spectrum, down syndrome etc. I am investigating the impact of the use of technology and games in the classroom on children's social and emotional health and skills. Considering the unique differences of children in special education classrooms, I will be exploring what needs exist for both children and teachers in the classroom environment and how these needs can be met with interactive toys. In this study, the diversity of social characteristics in children will be explored through observations and informal conversations in individual and inclusion activities at school. Later in the study, the behaviour of children and teachers towards an interactive toy ball will be observed.

The aim of this thesis project is to create a framework for generating concepts that capitalise on the unique needs and interests of children with different needs in order to encourage social interactions between children with different special needs and their teachers, families and friends. The result of this project will be an interactive toy ball that reflects the needs of children with special needs and their teachers, and the features that this ball should have, together with the benefits it can create, will be presented as a master's thesis aiming to inspire educators and families.

### What is investigated and why?

This study investigates the effect of the use of play and technology to improve the social skills of children with autism.

### Who can participate?

Children between 2-20 years old

### Will my child be compensated for participating?

No compensation will be provided.

### How much time will my child be expected to invest?

The research will be conducted by observing the student-teacher and student-student relationship during one-to-one education in the school.

### What are the rights of my child during participation?

Your participation in this study is voluntary. You may cancel your participation at any time without specifying reasons and without any disadvantages.

### Which data are collected?

Qualitative data on children's behavior and emotions while interacting with their teachers and friends will be collected through the researcher's notes and drawings during the observation, and if necessary, photographs and videos will be recorded but personal information (faces, names) of the children will be anonymized.

### How will my data be handled?

The data will not be shared beyond the study team and will be used anonymized in the report of an MSc thesis.

### What are my rights to the data?

You may request comprehensive information about the personal data that was collected from you in the study at any time. You also have the right to have it corrected, handed over to you, barred for processing, or deleted. You may revoke your consent to the processing of your personal data at any time without giving reasons.

### What are the potential risks during the experiment?

The study will involve minimal interaction with the children and will not require them to do anything different from their normal activities during the activity time in the classroom supervised by the teachers. Children will not be asked to share any personal information with the researcher outside the scope of the study, nor will they be asked to do so if they are not willing to talk to the researcher. If a child feels uncomfortable at any time, the researcher will end the research session immediately.

For any additional questions or complaints, please contact the researcher:

Kumsal Kurt

K.Kurt@student.tudelft.nl



PLEASE TICK THE APPROPRIATE BOXES	Yes	No
<b>A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICIPANT TASKS, AND VOLUNTARY PARTICIPATION</b>		
1. I have read and understood the study information dated [.....], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	<input type="checkbox"/>	<input type="checkbox"/>
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	<input type="checkbox"/>	<input type="checkbox"/>
3. I understand that taking part in the study involves: <ul style="list-style-type: none"> <li>• Observations during school activities</li> <li>• Spontaneous conversations with therapists and children during observations and testing</li> </ul>	<input type="checkbox"/>	<input type="checkbox"/>
4. I understand that the study does not involve financial compensation	<input type="checkbox"/>	<input type="checkbox"/>
<b>B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)</b>		
5. I understand that taking part in the study involves the following risks: <ul style="list-style-type: none"> <li>• Emotional discomfort</li> </ul> I understand that these will be mitigated by ending the session if the child displays any signs of discomfort.	<input type="checkbox"/>	<input type="checkbox"/>
6. I understand that personal information collected about me that can identify me, such as name or school will not be shared beyond the study team.	<input type="checkbox"/>	<input type="checkbox"/>
7. I understand that the (identifiable) personal data I provide will be destroyed at the end of the project.	<input type="checkbox"/>	<input type="checkbox"/>
<b>C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION</b>		
8. I understand that after the research study, the de-identified information I provide will be used for a master's thesis report, which will be published and openly accessible.	<input type="checkbox"/>	<input type="checkbox"/>
9. I agree that responses, views, or other input resulting from the research sessions can be quoted anonymously in research outputs	<input type="checkbox"/>	<input type="checkbox"/>
<b>D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE</b>		
10. I give permission for the de-identified qualitative data that I provide to be archived in TU Delft repository so it can be used for future research and learning.	<input type="checkbox"/>	<input type="checkbox"/>

### Signatures

I, as the legal representative, have witnessed the accurate reading of the consent form with the potential participant and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

\_\_\_\_\_  
Name of witness

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

I, as the researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands what they are freely consenting.

\_\_\_\_\_  
Researcher name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

Study contact details for further information:

Kumsal Kurt

[K.Kurt@student.tudelft.nl](mailto:K.Kurt@student.tudelft.nl)

# Appendix 4 : Data Analysis Table

	Fizzy		Therapist		Child(ren)		Context		Objective(Therapeutic Goal)		
Sessions	Physical Action	Social Behaviour	Says	Does	Says	Does	Physical Activity	Social	Performance Measures	Notes	Initiated By
S.1.C.1	Rolls towards (to teacher)	Does what the teacher says	"Come with me Fizzy, now wait"	Gives commands to Fizzy		Looks at Fizzy, follows it	Parkour		Doing Instructions		
S.1.C.1	Rolls towards (to teacher)		"Thank you Fizzy, well done!"	<b>Caressees</b> fizzy				Physical Intimacy:Caresse			
S.1.C.1	Rolls towards,around the child and pause	Follows the commands of the child	"Let's see if it does what you say, you can talk to it"		"Come, play!"	Curiosity, Gets down on his knees looks towards fizzy	Floor, between sports materials	Child and the Therapist	Initial Introduction		
S.1.C.1	Rolls after (teacher)		"Can you come with me Fizzy?"	Goes further in the class and asks fizzy to come and holds it	"Can I take fizzy"	Eye gazing towards Fizzy and goes to where fizzy is	Being held by the teacher		Joint Attention; Class Rules		
S.1.C.1	Goes in a defined route	Modelling an activity	"Now it is your turn to do the parkour Fizzy"					Fizzy performs a task, the child watches what fizzy does from a distance.	Turn taking; Active Task Engagement; Modelling Kinesthetic Behaviours; Self Control(Movement)		
S.1.C.1	Goes to its place in the classroom, turns its lights off and stays still	Waiting for Child to perform	"Now it is your turn(to the child). Fizzy will wait you here and do it after you" "I told it to wait, it listens to me, so it will wait us"	Invites Child to the activity Space	"Fizzy will you do the parkour?" ; "Do it Fizzy, Do it Fizzy"	Grabs Fizzy, shakes it, looks for movement. Resists on teacher's instructions, points fizzy to ask for performing, constantly looks at fizzy after each task completion				Child insists on asking fizzy to perform a task until he seems fizzy does not respond to his instructions and stays still. He asks couple of times "turn on, turn on!". 15.17 After finishing a task without fizzy, the child runs to fizzy and says "come fizzy, come fizzy." He was really excited to give it commands and make it work by his words but to keep the class's flow it was only following when the teacher wants it to be a part of the activity.	
S.1.C.1	Being Taken Away by the therapist	N/A	"It can only do if you do your turn, otherwise I will take it back, should I do that?"	Holds Fizzy in his hands hides in his back where it is not visible to the child anymore	"No, don't take it away" "Put it down put it down"	Does the jumping with a single leg, unbalanced	Two-legged forward hop over cones			Absence of fizzy was an unwanted occurrence from child's side and he wanted to continue interacting with it. When Fizzy was taken away, the child still asked for its existence by saying "put it down"	
S.1.C.1	Goes in a defined route (before the child)	Works as reinforcer	Fizzy will show you which direction to go			Hops with two legs forward	Two-legged forward hop over cones	The child and Fizzy stands next to each other, The child moves together with Fizzy	Motor Skills: Kinesthetic Behavior; In motion together	The movement of fizzy should be able to controlled by teacher in a way that its actions should be limitable by the teacher.	
S.1.C.1	Not Responsive		It will not work if you don't do your task.			Does not follow instructions, quits the activity and give commands to fizzy			Negative Punishment;Classroom RulesActive Task Engagement	The movement of fizzy should be able to controlled by teacher in a way that its actions should be limitable by the teacher. Happens 7 times.	
S.1.C.1	Being Taken Away by the therapist		"I will take it, you are not doing what you are supposed to do"	Takes Fizzy from the ground	"Don't take it don't take it, i will do my task"	Does not pursue on the task but shows attention to Fizzy			Reasoning; Cause and Effect	Child did not like fizzy's absence and to have it back, he performs his tasks	
S.1.C.1	Not Responsive: Stays Still(inanimate)	Being rewarded with a sticker	"It did its tasks very well so I gave it a sticker"		"Fizzy will win the race" "Can I hold it?"						
S.1.C.1	Not Responsive	Waiting for Child to perform	"Fizzy he does not do his task do you know"	Guides the child through the parkour		First stops while doing tasks then after hearing what the teacher says, he starts engaging with the activity again			Negative Punishment;Classroom Rules	feeling ashamed about his disobedience being announced to fizzy(play partner) made him motivated	
S.1.C.1	Rolls towards,around the child and pause	Listens to the instructions	"You did your tasks well now fizzy will listen to what you say"		"Fizzy come"					The therapist was giving the reward of engaging with fizzy to a child if only the child engages with the activity. This enables teacher to attain his goals while also providing something fun in return. (It was not directed by the designer to do that but it was therapist's approach towards it and how he made the activities gamified with the help of fizzy.	
S.1.C.1	Rolls around without an identifiable pattern	Promotes playing tog	Try to catch it			Runs after fizzy, tries to catch it, crows			Hand Eye coordination; Gross Motor Skills;		
S.1.C.1	Stays still, emits "YUPPI" sound				"YEYUU"	Imitates the sound of fizzy					
S.1.C.1	Leaves the activity area		"Fizzy is so tired now, now it will get some rest"		"GoodBye fizzy"	Waves at fizzy			RolePlaying; Pretent Play		
S.2.C.2.3	Comes from its dedicated area towards to therapist	Gives the first impression	"I have a surprise for you, now fizzy will do the parkour with us, fizzy can you come to me"	Does inviting gesture to Fizzy	"It came"( surprised)	Laugh, Stand up from their seats, go near fizzy	Coming from the dedicated space(under the trampoline) where it was not obvious to the children before it moves	two children sit next to each other when fizzy comes from its dedicated area	Initial Introduction		
S.2.C.2.3	Goes in a defined route	Does the activity correctly and	"Fizzy now you have watched them(kids's names), you know how to do the parkour. Do it like how they did it		"Yeees! You won!"	Eye Gaze, follows where fizzy goes. Smiles, celebrates when it scores and claps to the teacher.	Going in between cones and scoring a goal	It is happening after children completed the parkour without fizzy once each.	Modeling Kinesthetic Behaviours, Active Task Engagement		
S.2.C.2.3	Rolls towards,around the child and pause		"See it does what I say, you can also give commands and see if it does what you say."	Watches children and fizzy from a distance	"Come fiz!" "Fiz go"	Sit on the ground and gives commands to Fizzy, laugh		two children			
S.2.C.2.3	Goes to its place in the classroom, turns its lights off and stays still	Waiting for the child's turn to perform	"Now everyone should wait in their place";"Well done to all 3 of you, now its [Child 1]'s turn" "Yes see fizzy is watching and waiting us so well now"		"Fizzy is watching us w-right?"	Does the parkour		two children	Turn Taking		
S.2.C.2.3	Comes to the eye sight, stops Rolls in its own axis:right and left	Getting Excited, Celebrating an achievement	"Fizzy is so happy that you did it"			Celebrates an achievement and looks at fizzy if it gives reaction		two children			
S.2.C.2.3	Rolls around without an identifiable pattern	Chasing Teacher				Runs after fizzy, tries to catch it, crows	Chasing fizzy and trying to catch it	two children all the time	In motion Together Joint		

									Engagement; Basic Movement Skills; Gross motor Skills		
Rolls around; not reactive to commands	Disobedient	"Fizzy, I told you to wait, go back!"		"It does not wait!"	Complains about fizzy to the therapist				Attention Span; Fair Treatment		
Leaves the activity area				"Fiz will go to its mom"	Watches the ball as it goes	Goes to an area where it is no longer visible to the subjects			Pretended Play; Role Playing		
Rolls towards, around the child and pause	Follows the instructions			"Ball come on come"							
Rolls back to the subject when being kicked	Used as a ball that "wants to be played with"	N/A	N/A	"Let's go"	Kicks the ball						
Held by the child	Object of joint engagement	N/A	N/A	"It became blue"	Shows Fizzy to his mom	The child places himself holding fizzy and sitting next to his mom, after the session	The child approaches to his mom to show the ball	Joint Engagement			
Rolls towards to other Therapeutic objects while changing colour	Modelling an activity	Oh which colour is it, it goes to blue and turns blue, says that you should jump into one		"Blueeee"	Looks for Fizzy's colour, follows fizzy and steps in the hoop that has the same colour	The child jumps into the hoop that fizzy indicates with its colour and movement	The child, coloured hoops, fizzy, the therapist	Multi Step Directions; Active Task Engagement			
Stays still, changes colour		"which color does it show?"	N/A		Choosing a pompom that matches with fizzy's colour and blowing it out from a high surface	The color of Fizzy acts as an indicator to put and blow pompom on a surface in the same color	The	Doing Instructions; Verbal Abilities; Communicative Speech; Cognitive Development (Color); Multi step Directions; Receptive Language			
Leaves the activity area				"Go home Ball" "Bye Bye ball"	Sits on the therapist's lap watches the ball as it goes	Goes to an area where it is no longer visible to the subjects		Starting, pursuing and Finishing an Activity; Pretended Play (characterising the ball)			
Rolls around without on identifiable pattern while turning on and off its colors in a dark room	Prompts hide and seek	"Catch it" "where did it go"	Runs around with the child	"I see it" "I caught it" "where is it"	Runs in the room	A dark therapy room where fizzy roles around in a dark and colored mode		Attention; Gross Motor Skills			
Comes from its dedicated area towards to therapist	Gives the first impression	"Now in the next round fizzy will do the parkour, Fizzy can you come?"			Eye gaze			Initial Introduction			
Rolls towards, around the child and pause	Follows the commands of the child	"You can also give command to it"		"Come Fizzy" ; "Go Fizzy"				Eye Gaze; Joint Attention; Mediating the Activity			
Rolls away from the Subject	Encounters a threat			"Where are you going fizzy"	Falls while doing the activity	Balancing on a balance board while fizzy is standing besides the child	Fizzy rolls away to save itself from a threat (falling child)				
Comes to the eye sight, stops Rolls in its own axis; right and left	Getting Excited, Celebrating an achievement	"It is celebrating you"			Looks at fizzy and caresses it	Scoring a goal	Fizzy stands near the activity area which is visible to the child but not on his way to block the scoring area.	Joint Engagement; Shared enjoyment; Success and Team Play	The child here looks for reassurance from fizzy to share his achievement by looking at what fizzy does after he succeed on a task.		
Goes to its place in the classroom, turns its lights off and stays still	Waiting for child's turn to perform			"Fizzy wait for me"	Does the parkour	Parkour; jumping over cones	Fizzy waits at the beginning of the parkour where it has been told, while the child still wants to communicate with it verbally.	Starting, pursuing and Finishing an Activity; Pretended Play (characterising the ball)			
Goes in a defined route (before the child)	Makes mistakes on where to go	"No, you did it wrong, go back to the beginning"			Laughs at fizzy			Fair Treatment			
Comes from an invisible area dedicated to it towards the activity area		What is that?, What kind of a toy is that?		A toy; A car	Smiles and looks at fizzy	Two children observe fizzy		Initial Introduction	Child 4 is the one whom we wanted to test with since he has a down syndrome.	The therapist wants to place fizzy somewhere it is not visible to the child. He wants to have its lights turned off when fizzy is not part of the game	
Rolls around without on identifiable pattern	Tagging					Two children running after fizzy	Fizzy introduces its movements to children	Initial Introduction	Fizzy should have a mode in which it escapes from obstacles with a proximity sensor. It can be a nice introduction game for children	The therapist wanted to introduce fizzy as a moving object by letting children play with the ball. He said you can try to catch it after the designer told him we can let children play tagging with it	
Rolls away from the Subject while changing colors		Now the ball will roam around and you will try to catch the ball before it reaches to the cones. If it is blue, child A can move, if it is red child B can move okay?		"It is so great! I wish we could try to catch it with two people"	Runs after fizzy, tries to catch it	The ball will roam around and you will try to catch the ball before it reaches to the cones. If it is blue, child A can move, if it is red child B can move.	Children get excited for each other's turn which is an indicator of the active task engagement.	Multi Step Directions; Gross Motor Skills, Turn Taking; Winning and Losing; Active Task Engagement	The color illumination of fizzy should be accessible to children with different needs for example the child with down syndrome was not able to see the colors clearly from Sphero. The teacher wants to allow both win and lose mechanisms. Children look for an indication when they beat fizzy, they want fizzy to celebrate their achievement by shaking it. Sometimes children also comes up with ideas and fizzy should be adaptable to those situations.	The teacher sees the color of fizzy changes and comes up with an activity. One of the children wanted to play with the ball as a group game, where one of them could win. This refers to its ability to group and team play	
Rolling on a small surface to stimulate balancing games	Balancing Fizzy by changing the angle on a surface	Longest to keep the ball on the surface wins	Records children with his phone	"It comes to you (to his friend), you should control it"	Focuses on the ball while	Two children take turns on balancing the ball on a surface. Longest to keep the ball on the surface wins		Hand Eye coordination; Fine motor Skills; Team Play	approx 17 minutes	Facilitated by the therapist. He came up with that activity after the catching game.	
Rolls around without on identifiable pattern		"Oh shall we catch it, where are you ball?, Ah it is running away from you"	Guides the child to fizzy		Looks around and looks for the ball when the therapist pushes him to				The child is not very enthusiastic about the ball	When the teacher saw that it moves, she suggested to catch the ball to the child. Rolling prompted catching	



						engage with the ball					
E.2.C.8	Rolls around without an identifiable pattern while turning on and off its colors in a dark room					Not very enthusiastic about it only does when the therapist pushes him to do so. Crawl towards the ball					The therapist
E.2.C.8	Rolls back to the subject when being kicked	Wants to played with	"Which color should it turn into?"			Rolls the ball with his feet and walks with the ball			In motion together		
E.2.C.8	Rolls around without an identifiable pattern		"Catch it catch it"	Sits next to the child	-	Rolls the ball with his feet and walks with the ball			In motion together		
E.2.C.8	Held by the child, moves on its own axis	A thing	"It dances inside do you see?"		-	Holds the ball, looks at it carefully, inspects it, sometimes puts it back to the floor and when the ball comes	Sitting cross legged next to the therapist and holding the ball		Initial Introduction		
E.2.C.8	Rolls towards, around the child and pause						Crawling	The child and the therapists sits together on the ground and the therapist speaks up the what is happening	In motion together; Introduction		Fizzy
E.3.C.9	Not involved	Not part of the game		Sings a song to the child while swinging him		Sits on the swing and completes the parts of the song	Child wearing a weight vest and swinging on the swing with disco lights on		Vestibular Sense		
E.3.C.9	Rolls around without an identifiable pattern while turning on and off its colors in a dark room	Thing, slow	"AAAA what is that?? Which colours should it have, should it escape??"	Watches the child and fizzy from a distance		Approaches the ball, holds it, shakes it	Dark room, fizzy changes colours, being held by the child and when its released it goes slowly	Therapist, child and fizzy			
E.3.C.9	Held by the child		"Congrats, well done"	Watches the child and fizzy from a distance		Looks at the ball while holding it, walks around	Dark room, fizzy changes colours, being held by the child	Therapist, child and fizzy	Getting to know	The therapist asked for vibration at that very moment but it was not possible with that prototype.	Fizzy
E.3.C.9	Goes in a defined route (before the child)	Prompts where to go (in a parkour)	"It waits for you at the end of the tunnel"	Sits next to the tunnel		Crawls in the tunnel through to fizzy	A tunnel, dark room and	Therapist, child and other therapeutic objects and fizzy	Vestibular sense, Gross Motor Skills, in motion together, Hand eye coordination	The therapist came up with an idea that with a child whose cognitive and responsive ability is good, they can play a game that they can play different foods to each other by changing the colour of the ball.	The therapist
E.4.C.10	Comes from an invisible area dedicated to it towards the activity area	Thing, slow	"First let's get used to the movements of it and then we can play games with it."			Approaches the ball, holds it, shakes it, looks for what is inside.			Getting to know ;Initial Introduction	Some I.p.'s can be merged together. For example a group in which it says the <b>initial introduction and which patterns enables that.</b>	Child
E.4.C.10	Rolls around without an identifiable pattern while turning on and off its colors in a dark room	Thing, slow ; Rolls away from the Subject while changing colors; Rolls towards, around the child and pause	"It goes, will you be able to catch it?" "Let's let it escape once again"		"I caught it"	Crawls and walks after fizzy, holds it, releases it	Catching fizzy	Fizzy, the therapist, and the child	Getting to know ;Initial Introduction	Fizzy's prototype here was not tightly closed so the child opened up the prototype in half.	Therapist
E.4.C.10	Rolls in between the child and the therapist while changing its colours to which colour they say	Dynamic object that connects the game the child and the therapist	"Which colour should it be, hmm yellow, tell me a fruit with a yellow colour"		"I want banana!"	Holds the ball, says a fruit and put it back to the floor and gives it a push	Sitting in front of each other, their legs open and creating an environment in which fizzy would move in between their legs. floor time	Fizzy, the therapist, and the child, sitting.	Recalling; Free Recall; Joint Engagement	It is a game initiated by the therapist. In one of the previous session when she saw the colour change of fizzy, the colour change sparked this game on her and she initiated this game and she knew that this game would be suitable for this child so she wanted to test it in that session.; Maybe here the interaction pattern can be reactive to the colour commands	Therapist
E.4.C.10	Not involved	Waiting for its turn. Waiting for child to		Guides the child through the parkour		Does the parkour	Taking an elephant toy from one corner of the classroom to take them to their "home" which is another corner of the classroom through parkour.	Gamifying the activity so that it has a meaning in the child's world.	Active Task Engagement; not getting distracted with fizzy.	The therapist wanted to play the game with the tunnel but then the designer suggested to play another thing first and then therapist approved that it would be nice to see the effect of it for getting the attention of the child.	Designer and the therapist
E.4.C.10	Rolls back and forth while changing colours	Guiding the engagement or the activity	"Oh which colour is it, hmm pink, give a pink ball"	Sits next to the ball pit with a bowl in which the child can put the ball in	"Pink"	Looks for Fizzy's colour, and looks for different coloured balls in the ball pit and finds the one that is pink	Fizzy indicates the colour of the ball that the child should take from a ball pit and the child selects a ball that is the same colour as fizzy's colour to put it in the box that the therapist holds.	Fizzy, the therapist, Ball Pit, Dark room, Child	Waiting; Being Patient; Multi Step Directions	Fizzy is guiding the engagement and the activity here	Therapist
S.5.C.11.12	Rolls towards other Therapeutic objects while changing colour	Modelling an activity	Look it shows you which ball to take and where to put			Puts the balls on top of to the cones with the colour fizzy shows	<b>Fizzy rolls around the cones while changing its colours to the same colour as the ball that stays on top of the cones to show which ball to take and then rolls to another cone to indicate which cone to put the ball</b>	Balance board, fizzy, cones, coloured balls, children	Joint Engagement; Multistep directions; Active Task Engagement; Gross Motor Skills; Hand Eye Coordination		Designer
S.5.C.11.12	Goes in a defined route (before the child)	Modelling an activity	It will show you yes, don't worry it waits until you do		<b>Fizzy should show me, first it goes then I go.</b>	Waits for fizzy to go to the beginning of the parkour while sitting and then goes where the ball is. Does the jumping	Hopping over cones	Cones, fizzy shows which cone to go next and waits until the next move, the other child sits and waits her turn	Active Task Engagement; Gross Motor Skills	The other child was still struggling to internalize fizzy while the other one was trying to engage with fizzy during the activities and in the buffer time	Therapist and Designer
S.5.C.11.12	Replaced with a ball; changes its colours to indicate where to be put at	Dynamic object that guides the engagement and the activity	Fizzy will show you which colored cone should you put it on by changing its colours	Watches from a distance	<b>It is blue</b>	Takes fizzy from a yellow cone to put it on the blue cone	Taking fizzy from on top of a cone and putting it on top of the cone that it shows the color of	The other child is still distracted but fizzy	Multi Step Directions; Active Task Engagement		Designer and the therapist

S.5.C.11.12	Replaced with a ball; changes its colours to indicate where to be put at	Dynamic object that guides the engagement and the activity	Fizzy will show you which colored cone should you put it on by changing its colours	Watches from a distance	It is blue	Takes fizzy from a yellow cone to put it on the blue cone	Taking fizzy from on top of a cone and putting it on top of the cone that it shows the color of	The other child is still distracted but fizzy	Multi Step Directions; Active Task Engagement		Designer and the therapist
S.5.C.11.12	Rolls around without an identifiable pattern	Tagging	"I will count to 3 and you will try to catch fizzy before it goes to its home, if you catch it before it goes there, you will win but if it goes in his home before you catch it, it will win."	Counts to 3 from a distance		Runs after fizzy, tries to catch it	Chasing fizzy and trying to catch it	2 children taking turns during the activity	Gross motor Skills; Kinesthetic Behaviour; Hand Eye Coordination		
S.5.C.11.12	Goes to its place in the classroom, turns its lights off and stays still	Listens to the instructions; Obedient	"Now everyone should go to their place, fizzy you should as well"		"Okay"	Go to their seats and sit there, looks at where fizzy goes	Going back to their seats	Chairs, Fizzy, 2 Children End of the class.	Following Instructions		
E.5.C14	Comes from an invisible area dedicated to it towards the activity area		"Oh what is that coming from"			Crawls through Fizzy, holds it, releases it	Crawling, following fizzy	Ergotherapy room, fizzy, child, other therapeutic objects, the therapist	Initial Introduction		
S.5.C.11.12	Rolls towards, around the child and pause	The get the attention of the child	"Yes you can look and explore it, what is that?"	Allowing the child to explore and play with fizzy		engages with other objects, when fizzy comes too close and touches him, holds fizzy and puts it on top of the materials that he is playing	Putting fizzy on top of the other objects that he is playing with and then puts it within a fabric and tries to swing it	Ergotherapy room, fizzy, child, other therapeutic objects, the therapist	Joint Engagement; Initial Introduction; Free Play		
E.5.C14	Held by the child, moves on its own axis	Thing	Let's play a game with it			Inspects fizzy by holding it			Getting to know ; Initial Introduction	The child gets to know fizzy by inspecting it	The Child
E.5.C14	Being shaken										
E.5.C14	Rolls away from the Subject	Escaping tagging	We will catch it when it escapes okay? 1-2-3!	Sits next to the child	Uttering joyful sounds	Crawls after fizzy, tries to catch it	Crawling, following fizzy catching and holding it	The child and the therapists sits together on the ground the therapist places fizzy in front of the child,	Joint Engagement; Kinesthetic Behaviours; Verbal Abilities		
E.5.C14	Rolls around without an identifiable pattern			Talks with the researcher	Uttering unrecognizable voices	Holds fizzy and puts it to several places, tries to catch it before it falls	There is no guided physical activity but the child initiates to engage with fizzy		Free Play		The Child
E.5.C14	Rolls towards, around the child and pause		"Can you give that to me"	Tries to set up the next activity	Screams, Uttering unrecognizable voices	Realizes fizzy, runs after it, holds it		In between two activities	Joint Engagement; Getting Attention; Mediating; Verbal Abilities	The child does not collaborate with the therapist at the moment and plays with other tools in the room, and then fizzy comes closer to him to distract him from that object to get his attention to a more meaningful activity	Designer
E.5.C14	Rolls towards to other Therapeutic objects while changing colour	Prompts where to go (tunnel)	"Catch the ball from the other side of the tunnel okay?"	Rolls the child when he enters to the tunnel	Uttering joyful sounds, "ball"	Crawls in the tunnel through to fizzy	Crawling through a tunnel trying to catch fizzy	In a tunnel	Proprioception Sense; Vestibular Sense Joint Engagement; Gross Motor Skills; Verbal Abilities	The child holds fizzy on his hands and still uses the tunnel. Then When he is in a tunnel the therapist rolls the child to work on vestibular sense	
E.5.C13	Comes from an invisible area dedicated to it towards the activity area										

To read and understand the table purpose of each cell in the table can be explained as follows:

1. Fizzy (as Tools, mediating artifacts in the activity system model) :

Physical Action:

Examination of the physical actions facilitated by Fizzy, including its movements, features and interactions with the environment.

Social Behavior:

Analysis of the social meaning of the physical actions. Such as waiting for the child to perform when the physical activity is Not responsive or Following commands when the physical activity is rolls toward the therapist. That includes responses and promoted social cues

2. Therapist (as Subjects in the activity system model):

Says:

Evaluation of the verbal communications initiated by the therapist, including spoken instructions, prompts, and feedback.

Does:

Examination of the therapist's actions and behaviors, including physical interactions, gestures and reactions with Fizzy and the child, and facilitation of the therapeutic activities.

3. Children (as Subjects in the activity system model):

Child's Says:

Analysis of the verbal expressions and communications initiated by the child, including responses to the therapist's prompts and interactions with Fizzy.

Child's Does:

Examination of the child's actions, non verbal communications and behaviors, including physical interactions, gestures and reactions with Fizzy and the therapist, and responses to therapeutic activities.

4. Context:

Physical Activity:

Consideration of the physical environment and its impact on the interactions and activities involving Fizzy. Explains what happens in the context, who and what is in the environment.

Social Context:

Examination of the social dynamics and relationships between participant(s) within the therapeutic setting, including interactions among children, therapists, and Fizzy.

5. Therapeutic Goals as Objectives:

Performance Measures:

Exploration of the overarching therapeutic objectives and goals initiated that are relevant to neurodivergent children's needs, mediated or adapted by Fizzy's interaction patterns during the activity duration.

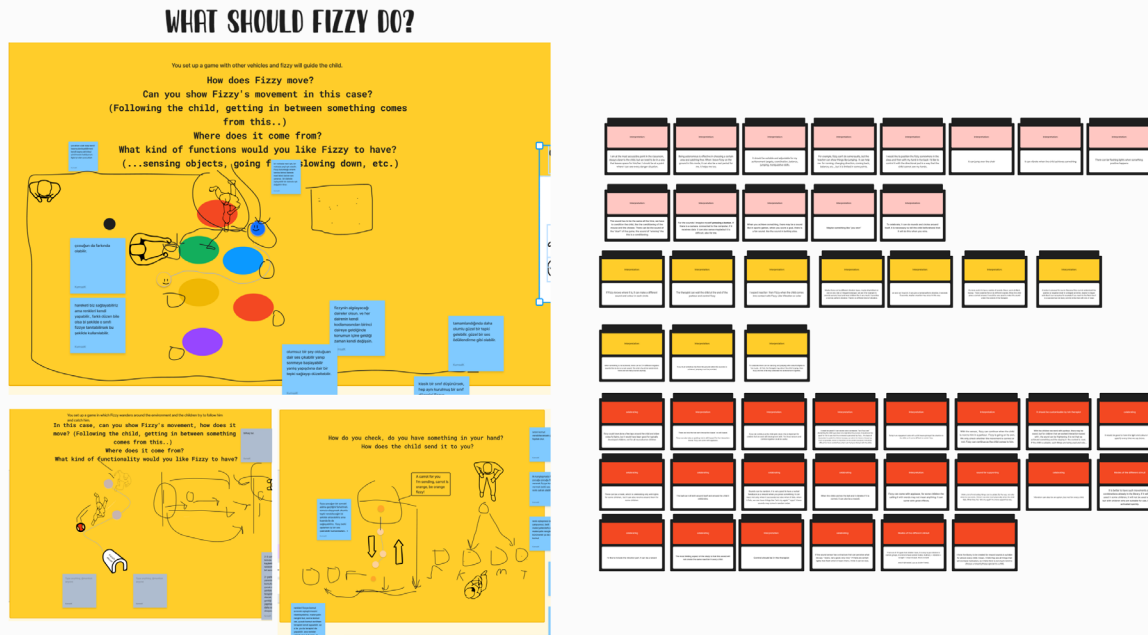
## Appendix 5: Different Prototypes of Fizzy





# Appendix 6: Data Analysis Method of the co-creation session

## Transcribing & Statement Cards



## Statement Cards x167



## Clusters x21

### Cluster 1

There can be Positive Feedback: Sounds&lights&movement for Rewarding the child

### Cluster 1

There can be Positive Feedback: Sounds&lights&movement for Rewarding the child

### Cluster 8

Fizzy can react to touch by vibration or lights

There can be Negative Feedbacks and Sounds for Improvement

Fizzy can be controlled by voice control

### Cluster 10

### Cluster 20

## Super Groups x6

### Super Group 4

Sensory Feedback and Interaction

## Appendix 7: Details of the Customization Process in the App

