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Cognitive Mapping and Human Robot Interaction: how to analyze the

interaction between children and robots

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February 2019

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Introduction

Nowadays, the study of human robot interaction in different system has become a popular topic. Although in literature some research has been performed to understand the aspects that affect HRI interaction, most of this research focus on the industrial robots in a production system. The research gap of studying the relationship between children and social robots has not been fully filled. And considering children's different capability compared with adults in terms of their language understanding and level of attention, the knowledge structuring approach based on observational methods would be more appropriate than self-reporting methods.

An experiment was performed and video recorded by Lupetti in a Chinese experimental elementary school (Yan Hu Qu) involving 12 children and a low anthropomorphism robot who can recognize different sounds by lighting up different colors. The experiment lasted for 2 hours and was consisted of four phases: preparatory phases (including playing musical instruments and creating groups), training robots, introducing color theory and game rules, board game playing. The data collection consisted of the video recordings of the experiment and the children's feedbacks through an after-experience questionnaire, however, children's identical answers to the questionnaire make the result not so reliable. Hence the video recording became a crucial knowledge. The result of the preliminary analysis, by applying Boris (Friard and Gamba, 2016) to identify useful recurring behavior of children, was affected by some difficulties of observing the group interactions in a real context. Therefore, an alternative approach was proposed in this research in order to reduce some of the natural limitations of these analyses and providing a framework to facilitate knowledge identification and structuring.

A knowledge base was created by means of repeated visualizations of the video recordings and the result was the transcription and translation of the actor's verbal expressions, plus a description of the facial expressions and behavior of twelve children, their parents, the Chinese and Italian tutors and a photographer, in relation to technologies (the robot, cameras and supplementary materials used in the game). Some constraints were found during the translation of the video recording in relation to understanding participants' expressions, such as children covering each other, multi participants speaking at the same time, children standing back with the camera or far from the camera. And these limitations were controlled by an individual focalization process to translate the words of each participant. A preliminary analysis was performed applying the concepts from Godspeed Questionnaire to the transcription to verify if

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some specific themes can be consistent with this situation. The consistency of these themes and their factors with this specific child-related robot application was tested by means of a structured reading of the text to identify elements in relation to the five sets of factors. The result of first analysis was that only two of the five main aspects of the questionnaire, together with new introduced aspects could be considered consistent with the experiment context, and the nature of Shybo. A conceptual model synthesized these elements and oriented a new analysis adopting cognitive mapping method to elaborate a multicriterian evaluation model.

A cognitive map can allow the visualization of the knowledge structure and the relationships between concepts. In this research, two kinds of map were created, the first to represent the different types of behavior of the children during the interaction with the robot and the engagement of the experiment, and the second to cluster concepts in order to analytically express the component elements of Likeability and Usability. The knowledge elements (actions, words and expressions of the involved actors, such as surprise, excitement or disappointment) that were acquired from the video analysis were included in nodes, and the relationships between the nodes can be identified in order to reduce the complexity that can be present in a concept (multiple meanings, ambiguity and difficult distinction between apparent or real contradiction of other concepts), to facilitate a clear, structured and transparent interpretation.

This process of knowledge acquisition and use produced a sequence of results which have different practical implications. The different profiles of children with respect to children's different capabilities to follow and react can be used to better define the role of the robots in education (O'Keefe, 2016) and at the same time to facilitate the definition of the multi-criteria model (Norese, 2016). The identification of some problem factors stimulated a risk analysis and proposal of risk mitigation actions, which can be very useful to better organize the experiment and evaluate the quality of the experiment. These knowledge elements were used to structure a multi-criteria model of the experiment quality, where children's mental and emotional engagement were proposed as criteria to assess the positive valence of the interaction between children and robots, which refers to *Likeability*, while the risk mitigation actions and the evolution of children's role were proposed as criteria to understand the efficacy of the experiment framework in other context and of this robot in other educational context, which refers to *Usability*.

Chapter 1

Research Context

Conducting research with children, who have different abilities from adults, in terms of language understanding and level of attention, is a challenging task, especially concerning novel interactive systems such as social robots.

An investigation of the implications of designing for children's playful learning with robots was carried out as part of a joint research that involved the UXD Polito research group, from Politecnico di Torino, and X-Studio, from Tsinghua University in Beijing by adopting a Research through Design approach (Lupetti et al., 2017). Research through Design approach is the process where designers make contribution to research by designing a product with experiment of new materials, process, technologies, and so on. (Danny G., Mithra Z., 2014). It has the aim to acquire knowledge and understanding from the design of an artefact.

The design process produced a set of prototypes of a novel low-anthropomorphic robot, Shybo (Lupetti, 2017), that were developed for investigating different aspects of a good child-robot interaction in an educational context. The design of playful learning experience for children requires the designers not only to define the artefact to be used but also to inquiry how children could relate their experience through the artefact or the experience.

An experimental application of the Shybo interaction with young children was developed in the Yan Hu Qu Experimental primary school in Yuncheng (China) and it was analyzed by means of some methodologies with the purposes of experiment evaluation and validation, as well as to propose a reference structure for the

organization of new experiments and the stimulation of new ideas and activities in the design process.

This chapter includes a first section that proposes the literature view on the design approach, above all in relation to interactive systems such as social robots. A second section proposes the description of the experiment and some evaluation of its results.

This chapter introduces the context in which was proposed a new methodology of experiment evaluation that will be proposed in chapter 2.

1.1   Literature review

1.1.1 Research through Design approach

Research through design (RtD) is an approach to inform a research question that takes advantage of the unique insights gained through design practice to facilitate understanding of a complex and future-oriented issues in the design field (Godin D., Zahedi M., 2014). It has been introduced by Christopher John Frayling in the Royal College of Art Research Papers (1993). In recent years, it has been widely applied in human computer interaction field. But its involving professional practice's contributions to knowledge makes it recognizable in any design field.

With regard to interaction of research in the design field, Frayling has introduced three different forms of interaction with different objectives, that is, the research through art and design, research into art and design and research for art and design (Frayling,C.1993). As reported by Frayling, *research in design approach* is the most straight forward forms of research and design interaction due to huge amount of models and archives, and it is mainly performed in universities to contribute to dissertations about design studying through the historical research, aesthetic or perceptual research, and a variety of theoretical research on art and design including social, economic, political, ethical, cultural, technical, material and so on; *research for art and design approach* aims at facilitating design practice to document knowledge in the design process through visual or iconic or imagistic communication, finally resulting an artefact as end product with thinking embodied; *research through art and design* aims to achieve and communicate the research result through the activities of art, craft or design.

According to Kenneth Agnew's view in Frayling's report, in most of the time, research through art and design is hindered by the lack of any fundamental documentation of the design process which produced them, more often, the only evidence is the object itself even the evidence is ephemeral. With regard of this problem, Frayling has identified three fundamental elements of research through art and design approach: Materials research, Development work, and action research. Materials research refers to experiment with new materials through design process; Development work is to customize specific technology for a novel application and communicate the results. One example mentioned by Frayling is that the Canon color photocopier was successfully used at Royal College of Art by some postgraduate students to illustrate their exhibitions and writing up results. The last element, action research refers to communicate the results through a step by step telling way of a practical experiment recorded in a research diary and a resulting report to contextualize it.

Considering the design process as the evolution steps of variation-selection and re-stabilization, Danny G. (Danny G., Mithra Z., 2014) has reported that the reality described by RtD is not "how things currently are" but "how things will be", which means the one that comes out of the synthesis of the variation from current state and selection of the ideal state. Consequently, The contributions of RtD, as a design theory, should spawn from the evolution of design practice and at the same time, lead towards a more significantly or efficiently fulfilment of designed artefact.

To address the added perspective of design thinking in a collaborative research environment, a model and a set of criteria for evaluating the quality of interaction design research contribution was provided by John Zimmerman (John Z., et al., 2007). In his model, interaction design researchers integrate the true knowledge from behavioral scientist with the how knowledge demonstrated by engineers in order to ground their explanation in real knowledge produced by anthropologists, and the final output is a concrete problem structure, articulation of the preferred state and a set of artifacts. The evaluation criteria considers four aspects, namely, process (providing enough detail that the process can be reproduced), invention (a novel integration of various subject matters to address a specific situation), validity (a demonstration of the performance or the function of their contribution), and extensibility (the ability to build on the resulting outcomes of the interaction design research).

The intent going into the research through design is to produce knowledge for the research, not to make a commercially viable product. To this end, research through design approach produces several beneficial contributions for interaction researchers,

above all the identification of opportunity for new technology, the creation of artifacts with concrete combinations of theory and technical opportunities, and the framing of problem that balance the intersecting and conflicting perspectives of researchers.

1.1.2 Playful learning with robotic constructions

With the development of technology, robots are not in fiction any more, but existing in our life with different forms, from mechanical to humanoid, supporting in different fields, from industrial to society. At the same time, the application of robots in the educational context in terms of supporting a playful learning experience for children has become a popular research.

To design of playful learning experiences for children requests the designers not only to define which artefact to use, but also to investigate the ways how children may enable relate the artefacts with their own concepts or experience in order to construct new knowledge. In this regard, Resnick has reported three underlying principles in their research about how to expand the range of knowledge that children can learn through the interaction with physical objects, that is: encourage design projects, leverage new media, and facilitate personal connections. Resnick however, points out the fact that the introduction of new media is aimed at fostering creative thinking, not at developing creative technologies, and that the media per se cannot ensure a playful-learning (Resnick et al., 1996).

Some studies in application developmental science with youth development enable evaluate what children are able to learn with innovative technologies and how they learn it through construction kits. The program done by MU Bers named TangibleK robotics program is one example. The program observed in a supportive learning environment, young children, from 5 to 8-year-olds, can and will design and build animated construction behaviors through a robotic construction kit. The Thangible program data evaluation suggests that given age-appropriate technologies, young children can actively engage in computer programming and robotic activities (MU Bers.,2010). Another popular example of robotics applied for playful learning is LEGO Mindstorm developed at MIT. LEGO Mindstorm Robotic Invention system provides a series of product that includes programmable bricks, sensors, actuators, and other LEGO technics elements for children to engage in the knowledge acquiring in a playful context (Martin, F.G., 1994). These research contributes to bring ideas of computer sciences

and engineering into early childhood. The combination of programming and physical building of artefacts could foster the development of new ways of thinking (Resnick et al., 1996) in the end to encourage new reflections between life and technology (Martin et al., 2000). And thanks to this, children has the opportunity to access and comprehend the concepts that always considered as prerogative for adults, who can deal with symbolic and abstract knowledge (Resnick, 1998).

The concept of learning by teaching has been studied and practiced widely in the field of education (Roscoe & Chi, 2007; Aronson, 2000). Lee classified learning applications with virtual agents in computers into three types: teaching agents, teachable agents, and co-learner agents (J.-E. R. Lee et al., 2007). With regard to this, in some studies, robots are often conventional considered as teaching agent or care givers while being applied in an educational context (Tanaka F., Matsuzoe S., 2012). For instance, Gordon, M. has developed a programming toolkit, a DragonBot, embedded in an interpersonal interaction context with social robot involved, with which preschool children enable to experiment with computational concepts while having a playful interaction with social robot (Gordon, M et al. 2015). Tanaka and Matsuzoe constructed a new educational framework, with a care-receiving robot, a teachable type which receives instructions or care from human, to promote children's spontaneous learning through teaching the robot. In other studies, instead, the robot assumed different role: a mediator. Marti, P. and Iacono has investigated, by developing a mobile robotic platform IROMEC as a social mediator, the effectiveness of the robot in supporting the achievement of educational objectives in terms of encouraging children with disabilities to involve in a variety of play modalities (Marti, P.; Iacono, I). These studies demonstrated how children could benefit from a playful interaction with a robot as children's peers with regard to both engagement and learning.

The research process according to these studies present some common traits. An exploration phase is usually performed with related user engaged to collect particular user requirements either through interview or some joint activities. The exploratory study was particular meant to investigate the current scenario related to the context of application. Then the requirements guide the development of robot and its supplementary materials for carrying out the activities with children. The next step is to perform the experiments with children in order to test the performances of the robots to know whether it has satisfied children's learning needs and if children has enjoyed a playful experience during the interaction.

1.1.3 Robot design

The robot design process consists of two steps: an exploratory study to investigate the current scenario of children's play in urban area of China and the design of Shybo and its supplementary elements for carrying out playful learning activity in educational context (Lupetti et al., 2017).

The exploratory study (Lupetti,2017) consists of a series of activities including a set of forms for parents and activity for children in a hands-on workshop. Both activities were carried out involving a small number of participants including 9 Chinese children between 7 and 8 years old and one parent for each child. The exploratory phase aims to collect information about Chinese children's habit and their approach to perceive concepts in certain learning activities related to color, sounds, emotions and their associations. The activity performed in workshop comprise three different activities: acting and guessing emotions; drawing soundscapes; and associating sounds, objects and colors.

Through the exploratory process, a series of requirements concerning the experiment objectives was formed. On one hand, parents can provide detailed information about children's habits and daily activities, and even they can give suggestions on toys and activities designed for children; on the other hand, conducting activities with children allows a direct observation on a lot of their behaviors, such as, how they approach play activities, how they self-express, and how they might interpret specific elements of play, for example, sensory associations.

The set of forms for parents was composed by a consent and recording release form, a questionnaire, a child one-day agenda form, a child one-week agenda form, and a form where parents could shortly describe their children. The questionnaire includes 34 general personal questions to better understand how Chinese children spend pare time. The one-day agenda and the one-week agenda consisted the form where parents could record children's daily and weekly educational and play activities. These forms was designed to understand how much time children spent on education and entertainment. According to the questionnaire, four main aspects were found: children daily life, children play habits, parents engagement in children's spare time and parents' expectations and preferences on children's toy and play. It was found that children's daily life is tightly scheduled by dominated study activities and limited playing activities. Children usually had study load with 10 hours per day and 12 hours on average in the weekend, and they spend less than 2 hours per day to do free play or educative games on smartphone but rarely with role playing games (dolls, cars, etc) or

traditional games (board games, chess, cards). In addition, due to single child in family, they always play alone and they have less opportunity to be involved in social activities with parents, or other peers. However, it was a good observation that at least the children attended their interesting lessons as extracurricular lessons, such as musical instrument lessons, art lessons, and robot programming lessons. And children's regularly taking extracurricular lessons also has relationship with parents' opinion on toys. According to some open questions, parents preferred children to take part in the playful activities with an obvious educational aims, such as to promote children's hand-on skills, creativity, and even to help children understanding concepts of space, math, physics, chemistry and logic. With regard to the results, three requirements were defined with regard to those findings: fitting into existing habits, making clear the learning potential of the proposed solution, and promoting social engagement.

On the other hand, the activities performed in workshop aimed to gathering inspirational data rather than specific knowledge given assumptions (cited by Lupetti; Gaver et al. 1999). Three activities were performed: acting and guessing emotions; drawing soundscapes; associating sounds, objects and colors. In the first activity, 18 cards with 18 different kinds of emotions (happy, scared, angry, embarrassed, hurt, and so on) were distributed to 9 children. Each child were asked to perform and describe the emotions on their cards by gestures and facial expressions, and other children were asked to observe and guess which emotion it was and to write it down on a white board. Discussion was allowed amongst children who guessed. In the second activity, children were asked to draw the scenario while listening to five different soundtracks: a school bell, a city traffic, some cooking sounds in kitchen, nature with birds and water, and a luna park. After drawing, children were invited to stand up in front of all to describe their drawings. In the third activities, children were asked to associate the sounds they heard with colors. The sounds came from, by either beating, or squeezing, or shaking, a set of real objects hidden in a wooden box. And children were required to paste the card with the name of the object on a specific color of a color board in total with six different colors.

The first activity is the most challengeable one for children. Firstly, children has problem to understand some complex feelings and had no idea how to perform these emotions, and the same problem happened when other children were trying to guess the emotion the child performed; Secondly, children felt embarrassed to perform and they performed the emotions as static poses, rather movements; Thirdly, although children enjoyed the procedure a lot, they were afraid of making mistake; Last, children took

creative approach to explain the emotions they saw when they had no idea about the word, in particular, a boy, instead of writing another emotion, he used small descriptions of the expressions of the performing child, such as "What happened?" for worried, "Frowning" for embarrassed, and "cannot beat it" for scared.

In the second activity, children showed spontaneously engaging in activities. They were able to choose color freely to draw the soundscape but not requested to give explanations to the reason of choice, however, some of the children spontaneously gave the reason for their choice. And some similarities appeared in children's choice of colors. For instance, the drawing of urban traffic were mainly black with parts of light blue according to some children's explanation, it was because of the rain; for the soundscape of cooking sounds in kitchen, most children chose dark color such as: black, brown, and purple, and the reason was given by them that instead of imaging someone cooking in the kitchen, some of them imagined an accident happened in a factory, like the workers making things fall down, and another child imagined someone hitting a nail with a hammer; For the soundtracks of natural sounds, it was easy for them to recognized the things: birds and water, and they used nature-related colors: light blue, blue, green and yellow, but they also went beyond what they heard: all of them added some other elements that actually had no sound in the soundscape, such as dolphins, fishes and a tree; For the soundtrack of luna park and school bell, in which children used red to associate with alert, for example, one child explained he imaged a fire in the luna park and the fire scared people.

Despite of the similarities, children's peculiarity was a crucial aspect. Two of nine children had different impressions when heard the soundscape. For instance, instead of urban traffic, one of the two girls drew a boat under the rain, and a party instead of a luna park. After hearing other children's interpretation, they felt that they were wrong and did not want to explain their drawings. However, the point of this activity aimed to express impressions and situations evoked by the sound track but not to guess and draw correct. If she had described her drawings from a different point of view, the observation results would be enriched.

In the third activity, in the process of association sounds of objects with colors, some difficulties were found. It was a challenge for all children to associate the sound of an object such as plastic bag or metal objects (keys, pot and cutlery) with a specific color. However, children took different approaches: some of the children choose the color of a sound based on the color of the object's material, for instance, children associated sound of water with light blue; some children associated colors of the sound with

sound's characteristics, such as they thought red represented danger or alarm where children associate with scissors; While the others set their personal rules to clarify which color for which sounds, for instance, when associating a color with table, most children used orange maybe because orange was the most similarity color to the color brown, which was similar with the color of wood, However, one girl associated table with purple and explained that a table is normal and in her rules, red represented for strong sounds and purple was associated with normal sounds. Overall, the activity resulted engaging and enjoyable for the children who were constantly discussing cheerfully and changing their choices of the colors on the basis of the discussion.

Six requirements were concluded from the analysis of parent's answer about questionnaire and observations of children's behavior in workshop activities. Three requirements that came from questionnaire were: fitting into existing children's habits, making clear the learning potential of the proposed solution, and promoting social engagement. And the other three requirements defined according to children's workshop activities were: to involve the features of *controllable by children* as one of design objectives, by considering to create a robot on which children could *create rules or tell stories* through a development approach of *open and customizable experiences*.

In addition with respect to users' requirements, the design of robots also concerned other specific aspects acquired from literature. Mainly, three aspects had to be considered: *morphology, nonverbal behaviors* and *interaction schemes* (Luria et al., 2016). Regarding morphology, the robot needed to have an iconic appearance and provide some physical affordances. The lifelike features can increase attractiveness and the sense of familiarity (Blow et al. 2006) and physical affordances (Hartson., 2003) can facilitate user's interaction. With regard to nonverbal behaviors, the robot needed to express different statuses through movement and show a clear input-output relation, because the sense of animacy and causality of statues spontaneously emerge with the visual of movement (Hoffman and Ju 2014), and in reference to Ackermann's work, he explained the connections between sensitive toys and children's actions control on toys. Finally, the interaction schemes identified two requirements: on one hand, use robot as a mediator of the interaction to motivate children to interact with physical environment; on the other hand, give control of interaction to children at a certain level referring to Ackermann's report that giving control determines a feature of the toy.

With these requirements collected both from exploratory studies and preliminary research, a trainable sound-reactive robot, called Shybo, was developed. The design process included sketching, prototyping, and documentation of the various ideas.

Sketching was practiced to define possible strategies to answer the requirements in order to support to explore design ideas. The introspection of the preliminary idea of a robotic toy emphasized the necessity of designing a robot with personality and defining a simple and legible functional principle. And with reflection to the possible combinations of senses and reactions embedded on robot, a variety of meaningful combinations could be defined: color-sound, temperature-texture, and texture-sound. But considering the limit time span to prototype and test, the only combination of sound-color was chose.

The prototyping phase of the project consisted of a series of different prototypes. Each of these was developed with a different technique according to its purpose, and a series of paper models and physical computing platforms were drawn up to explore morphology, non-verbal behaviors and a possible interaction schema. The first two paper prototypes were aimed at investigating morphological aspects of the robot, and both of these two prototypes focused on the element: hat. The hat was designed to express different states of the robot and according to its position, the robot might look active, calm or scared. Furthermore, the first prototype also aimed to reflect the requirement of iconic appearance by few minimalistic elements. And the second prototype also focused on the aspects of providing physical affordances. Hence a round shape was identified so that children could grab it and hold in their hands. Then interactive prototypes followed to developing a training mode of the robot. Some hardware components with morphological characteristic were defined to facilitate the interaction in training mode: a button as the mouth of the robot, the potentiometer as the nose and the LED ring and microphone as the eye. After this, a low-fidelity semi-functioning prototype was developed which focused on the function rather than morphology with aim to improve training mode and develop robot's behaviors. In this phase, 3D models was developed both to investigate the morphological and aesthetical aspects (made by CAD software Rhino) and to simulate the movement and the light behavior (developed by Blender, an open-source software for 3D computer graphic). Finally, a high-fidelity and semi-functioning prototype was developed by 3D printing. These five prototypes aimed to develop the morphology and main function and to test these two aspects. The robot's non-verbal behaviors, hat's movement and light animations answered to the requirements of having explicit input-output relations. In addition, the animations of eyes and body light transitions were improved respectively for training mode and playing mode.

The result from this design process is Shybo, a small low –anthropomorphic robot that perceives sounds and reacts by lighting up in different colors and non-verbal behavior, namely the movement of the hat (Lupetti et al., 2017). Shybo is designed intended to be part of class learning experiences with groups that can help children construct knowledge of academic contents or more abstract concepts, such as identity and emotional intelligence. It fits the educational purpose, consists with children's existing habits and satisfied the requirements of promoting social engagement. With round shaped head, the need for providing physical affordances to children during interaction was satisfied. Two modes, training mode and playing mode, could be switched by a switch at the bottom surface of Shybo. The intuitive training mode consists of simple actions: switching modality by the switch, selecting a color by turning the nose of the robot, and recording sounds by pushing the robot's mouth.   It can record multiple sounds with respect to the same color so that children could choose to make sound with any objet and compared the similarity of the various sounds. In this way, Shybo can be used as a mediator between children and elements of physical environment, such as musical instruments or daily life objects could make sounds.

1.2 Experiment description and original evaluation.

An experiment to test Shybo's performances in terms of likeability of children and usability in future educational context was conducted after the design process. The experiment was presented at a Chinese experimental primary school. And 12 children (half male and half femal) were selected from different classes by teachers, aged between 6 to 9 years old. One parent of each child was asked to answer a questionnaire while children were doing playtest, and in the end parents were invited to join the game with children together. The parents, aged between 28 to 41 years old, were eleven females and one male. Seven of them are teachers, two are farmers, one is a legal assistant, and one is an accountant.

Some supplementary materials for the experiment were prepared in advance including: twelve musical instruments, five colored paper cards, four boards of colors, a board game, a deck of question cards, and a sand glass. The musical instruments were either existing (bass drum, snare drum, harmonica, clarinet, small bells, cymbals, plastic allegro,) or custom made (round maracas, long maracas, empty box, plastic sticks, metal sticks). And five colored color cards were: orange, yellow, blue, purple, green.

The experiment took place in a meeting room of the school where often hold school activities, and it was a familiar context for children. And the whole activity, lasting for 2 hours, were mainly divided into four phases. In the first phase, children were invited to play musical instruments, create groups of similar sounds and choose a color for the group; In the second phase the robot was introduced to children and every child, group by group, was invited to train it by making sounds; In the third phase, some color theory and game elements and game rules were introduced to children; In the last phase, children were divided into teams and played the board game.

1.2.1 First phase

Children were invited in the meeting room and they were told that they were going to participate in an activity here, and each of them were gave a number from 1 to 12 to represent themselves in this activity. The Chinese tutor asked all the children to stay in line. Children were very polite and followed tutor's instruction carefully. 12 musical instruments were put on the table behind children, and the Chinese tutor told all children that in order to play the activity, first of all each of them had to choose one instrument on the table. Then all children came around the table happily and picked their instruments.

Children were asked to stand in line and play the musical instruments they chose one by one. These musical instruments, either existing or custom made, were very common in Chinese primary school when children having music lessons or joining chorus, so almost all the children knew how to perform it immediately. However, there is one child, N.7, he chose harmonica, but he had no idea how to perform it. He asked Chinese tutor for help, and the girl, N. 10, stood beside him, and Italian tutor also came to teach him. And he learned very fast.
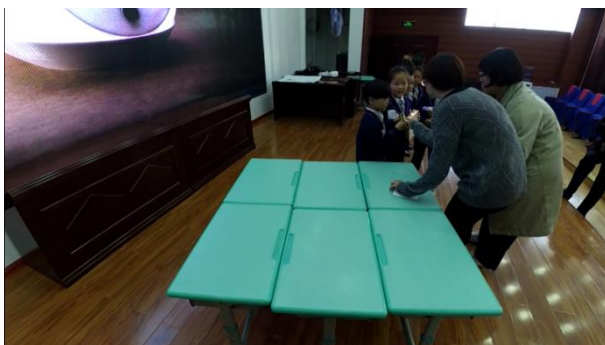

Figure 1.1 Tutors and children were helping N7 to learn how to performing the instrument.

After learning how to play the instruments, children were invited to make groups with other children whose musical instruments had similar sounds. In order to guide the children, the Chinese tutor took the following approach: she asked the children to perform the musical instrument one by one according to increasing order of their numbers; and asked other children to put their hands up if they thought their musical instrument had similar sounds; then the tutor asked those children to perform their musical instruments again to recognize the similarity again; and finally, the children who recognized the second time the similarity would form a group together. Under this instruction, children had the opportunity to compare the similarity themselves and tutors could gave instructions to children who had difficulty of comparing the sounds. For instance, when tutor asked N.2 to perform his instrument, both N.3 and N.6 thought their musical instruments were similar to N.2. But when the tutor asked these three children for the second time recognition, they had difficulty to tell that all of them three belong the same group. After tried a few times to let them play the musical instruments and compare the sounds, they still had problem, so the tutor decided to skip them for a while, and gave them instruction at the end. By asking to other children if they could recognize that they belong the same group, tutor found that it was a difficulty for all children, so she told them that the similarity of these three sounds is because that these three musical instruments were all mental-made, hence, these three belonged to the same group. Some other acoustic principles were mentioned by tutor when other children were making group, for instance, the tutor told children that the instruments of N.5, N.10, and N.11 performed similar sounds because of the cavity part of their musical instruments. In this step, children were all showed their interesting about the experiment process and they followed the guidance of tutors carefully.

After forming the group, each group were invited to select a colored cards to represent their groups, which means, represent the sounds of their musical instruments to prepare for the training of robot according to color-sound association in the next phase. The tutor, again, took the approach to let children to choose color by themselves. In this step, when children had different opinions about the choice, they always communicated with each other in order to have an agreed decision. Children showed great interest about the colored cards and they talked with children from other group and compare the colors with each other.

Figure 1.2 Children were choosing colored card to represent sounds of their group

This phase was the first chance to delivery knowledge to children, mainly to help children to create concepts of quality of sounds. The mediator between children and those concepts were twelve musical instruments. As the beginning step of the experiment, the common and custom made instruments could make children feel relax and even excited very soon. During this phase, all children behaved very well and followed tutor's instructions carefully and their obedience was due to their interest of the procedure.

1.2.2 Second phase

The second phase started with a video presentation of Shybo's functionality.

The tutor told children that they were going to play a game using these colored cards and their musical instruments with a small robot, named Shybo. Children immediately realized that it was the robot showed on the projection screen, and they showed a lot of interest and asked some questions about Shybo. For instance, one girl asked" it had no hand, how could it play with us?" and the tutor did not response immediately but told them that they could get to know Shybo more through a presentation video. The presentation video lasted for about two minutes, and in the video, Shybo light up different colors. With respect to this, many children felt very amazing and they discussed a lot when watching the presentation video. For instance, one child said "it is a light", when seeing Shybo light up; another child said "It can light up different colors"; another child said it looks like the robot he saw on TV (*in Chinese TV shows or broadcastings, it was often to see a kind of small robot with round head and round body, but not human shape, made in white and could talk with children*); and some other children spoke out the colors following Shybo's lighting up. After the presentation video, some children felt confused and they expressed that they could not understand

what the video was talking about. So the tutor explained to them that Shybo was a small robot with function to light up different colors with respect to different sounds.

Then, the Italian tutor Lupetti took out Shybo and put it on the table. It was the first time children saw Shybo and they were laughing and yielding to express their excitement. See children's curiosity, the tutor explained to them this small robot was Shybo, and with respect to children's knowledge that robot had hand and leg, tutor told them that not all the robots had legs and hands *(The reason was that in Chinese, the way to call robots is "mechanical man", so it was easy for children to have a imagine in mind that the robot they were going to see looks like a human, with hands, and legs.)*, Shybo was a robot with function to hear different sounds and light up different colors. With tutors' explanation, children became more interested and they would like to know how to make Shybo light up different colors. So the tutor told them next step is to learn how to train Shybo from Italian tutor.

Figure 1.3 Children first got in touch with Shybo.

Then the tutor explained to children about Shybo's different states of behaviors affecting the training process: calm, active or scared. In particular, tutors explained the scared states to children. Not directly told children the association between red color and scared state, the tutor put a question to make children think about seven colors of rainbow so that children could naturally find the missing color, red, in the colored cards. And when children answered to tutor's question together in a loud voice, Shybo lighted up red color and started vibrate its hat. Seeing Shybo's reaction, children could realize that hearing loud voice, Shybo would get scared by lighting up red and vibrating its hat. And they started to scream, laugh, play musical instruments, and beat the table to scare Shybo to test its reaction. It was obvious that children were very interested in this feature of Shybo, so they kept scaring it and enjoyed a lot. The tutor interrupted their behaviors and told children that Shybo would not like to play with them if they kept

scaring it. And this interruption attracted children to focus on how to play with Shybo so they put a lot of questions, such as: how it could play with us if it could not speak. The tutor answered to them that Shybo could talk through it's facial expressions, that is to light up different colors, and next step was for them to learn how to train it to light up different colors.

The tutor firstly introduced the control buttons of training modality: Shybo's nose and mouth. Tutor explained to children that the nose was used to select different colors and the mouth was pushed when Shybo was recording the voice. And children responded with the interjection word to express their comprehension or surprising, such as "wow" "ahh". Then the tutor presented to children how to train Shybo to light up yellow. In order to present, after setting Shybo in yellow category, the tutor asked one child, N.5, from yellow group to perform his snare drum, when Italian tutor was pressing Shybo's mouth. However, when the tutor wanted to test the training result, Shybo could not react to the sound of snare drum. After checking and testing for several times, the problem was found that the sound sensor was turned off. The tutors solved the problem and presented the training associated to blue with help of children N.8. One observation was that children could not keep quiet when tutor was presenting training. In the end, Shybo recorded children's speaking voice associated with blue and the tutor had to decide to train Shybo to light up another color to present Shybo's functionality of association colors with sounds. This time children learned that Shybo could learn only in a quiet environment and they did not make any noise. The last time training was successful and children saw with their own eyes that when Shybo heard the sound of beating plastic stcicks, it light up purple. Although some problem showed in this step, all children learned how to train the robot though these kinds of presentations and they had better comprehension about Shybo's functionality of color-sound association by watching and facilitating tutors solving those problems. And during this step, children showed their comprehension of the situation, for instance, some children beat the table or asked N.5 to beat it strongly to strengthen the sound since according to them Shybo's failure recognition the sound of yellow was due to that the sound of snare drum was not loud enough. In addition, children showed extremely concentration on tutor's presentation and explanation.

Figure 1.4 Tutor was presenting how to train Shybo to light up yellow

After the presentation, children were invited to train Shybo group by group. In order to avoid repetition, the training was performed only by children who did not invited in tutor's training presentation process. And those children who had trained the robot were invited to facilitate their group mates by taking action of pressing Shybo's mouth to record the sound. For instance, when blue group was going to train the robot, N.7 was invited to record the sound for his teammate by pressing the "mouth", and N.9 performed her instrument, the clarinet, and the same happened on N.8 and N.11. For the groups that all members were first time to train Shybo, a self-determined option would gave to all members to separate their work, one recorded the sound and others performed the musical instruments. For instance, before green group's practice, the children were asked to decide by themselves their roles, and N.3 intuitively offered to represent the recorder, consequently, N.2 and N.6 took action to perform the musical instruments: metal sticks, bells, and cymbals.

The training was performed following the order, green group, blue group, orange group, yellow group and purple group, randomly choose by tutor. Following tutor's instruction, they all trained the robot successfully one time. Every time one team finished their training, they would test Shybo's learning results with other groups who had performed before them. For instance, after the green group has trained Shybo to record their color, N.8 and N.11 were invited to test Shybo's capability together with members from green group. Starting from another color, N.8 performed his plastic sticks first, Shybo lighted up purple, then N.2 performed the bells, Shybo lighted up green, then N.11 performed drums and Shybo lighted up yellow. After all children has recorded their sounds, an one by one test practice was organized following children's number order. The test process was useful for children to visually understand their training performance. The test process used different modality of Shybo, the playing modality, in which Shybo could react to different sounds by lighting up different colors. Hence, when testing the robot,

the Italian tutor would hold the robot since it had not been introduced to Children the playing modality of the robot.

During this step, children all behaved very actively to be involved in the practice, for instance, every time one team has finished, all the rest groups who had not performed training would put up their hands and said "choose us, choose us " so that they could be chose as the next team to train Shybo. In addition, children put a lot of questions in this step, such as, one child asked to the tutor why Shybo could not imitate the sounds of his musical instruments, and another asked why Shybo could not talk with them. Some of these questions were answered by the tutor, while some else were ignored by tutor, since children sometimes put questions when tutor was giving instructions with other children. However, these questions proved children's curiosity with Shybo.

This phase was the knowledge application of the first phase, and the training process helped children to comprehend the logic of the robot's functionality, in addition, the association between red color and robot's fear inspired children's recognition about intensity of the sound and the control of loudness of voice.

1.2.3 Third phase

After training the robot, some color principles and game elements and game rules were introduced to children. Children left the table which was used for training process, but came around to the tutor in another corner of the meeting room and Shybo was still sat there on that table. The color theory consisted the knowledge of three primary colors, three secondary colors, and complementary colors of the three secondary colors. A color board was used in this step in order to help children's comprehension and. The color board had six colors on the board: three primary colors (red, yellow, blue), and three secondary colors (orange, green, purple). And the color board would serve also in next phase to help children figure out some questions about colors. Some children had a good knowledge of color theory compared to others, and this made them more confident and active to interact with tutors by answering questions. For instance, N.5 said he had learned three primary colors in painting lessons and he knew that these three colors were the basic colors in the world and with mixture they could generate other colors. Considering that there were children who had little knowledge, tutor explained the meaning and association of three primary colors and three secondary colors, and in addition, tutor taught children how to analyze the components of one color using the color board. And comprehending skills were important for next playing phase. Children all listened carefully and learned very fast. After tutor's teaching, children could

respond questions offered by tutor about color composition, such as, "which colors generated green colors?" or "what was result of mixing red and yellow?"

Then complementary colors theory were also introduced, and this theory was brand new knowledge for all children. At the beginning, some of them confused complementary color with components colors, but soon after, they understood the difference when the tutor made an example of complementary colors using the color boards. Generally speaking, almost all of them could comprehend this concepts fast enough. In order to test children's knowledge, tutor took out a deck of questions cards which would be also used in the next phase of board game playing. The tutor asked children to read the questions on the cards together and answered questions. Some questions written on question cards were: "which two colors composed the following color?" and "what is the complementary color of the following color?" The test result of children's knowledge was positive.

Figure 1.5 Children learning color theory

Next step was to introduce game elements and game rules to children. Children again showed extremely interesting in this step. Once the tutor took out the board game, they yield loudly "wow", came around the table immediately and happily, could not keep themselves to touch the board and intuitively spoke pointed out the route on the play board. And the board was used for children to compete the speed with others by following the rout on the board. Moreover, when Italian tutor out pawns on the board, they yield loudly second time and some children picked the pawns immediately. And due to the similar shape but smaller size of the pawns compared with Shybo, children call it Shybo's baby. The pawns was the tool for children to move in order to follow the route on the board. There were in total four pawns with different colors: red, green, blue, yellow. See some children were sad and worried about not having pawns in their hands, the tutor asked those children to give all pawns back and told them that four pawns would be distributed to them later. Another elements was a sand-clock which would be used to count time during the game, and it was designed with cycle time of one minute.

The last element was a deck of playing cards written different questions to test children's knowledge about colors, and the questions were similar to the example that tutor presented to children in the last step.

Figure 1.6 Introducing game elements (game board, pawns) to children

In order to made children have a better understanding about the function of each elements, the tutor asked all children to stand in line according to their numbers and introduced to them the rules of the game. And before introducing the rules, firstly, children had to be divided into teams to play. And knowing that the game was a teamwork game, children felt interesting and they repeated tutor's words "teamwork". The team, four in total, was divided by tutor according to children's numbers, which means, N.1, N.2, N.3 formed the first team, N.4, N.5, and N.6 formed the second team, and the same rules for rest children, that is, third group with N.7, N.8, and N.9, and last group with N.10, N.11, N.12.

Then the game rules was listed below:

1. Divided the players into group of 3 members, which means to have 4 groups;
2. Each group plays in turns. One turn last 1 minute, counted by sand clock;
3. During every turn, each member of the group has to do a different thing. One child reads the card, one takes the object (musical instruments), and the last child moves the pawn on the board. Every turn the children can exchange the role;
4. Every team has a card which has a colored circle or a description of colors. The teams have to obtain those colors on the robot by making sounds. The sounds were previously associated with colors by children in the training phase;
5. In one turn each group can do as many cards as it can. Every card done allows moving one step forward on the board.

6. If the robot gets scared by the sounds, the team lose the turn, unless the card requires the red color;

7. The team that arrives first at the end of the board wins.

After explaining the rules to all children, the tutor test children's understanding by picking several children to answer her questions about jobs of different roles. Some modifications were made when tutor explained the rules, she directly told the children that the children would be separated the jobs according to their numbers, which means, children with smallest number (N.1, N.4, N.7, N.10) would be the first one to play, so to read and answer the question cards, children with middle number (N.2, N.5, N.8, N.11) would be the second one to play, so to pick and perform the musical instrument to light up Shybo in corresponding color, and children with largest number within group (N.3, N.6, N.9, N.10) would be the last one to play, so to move pawns. Each team had a color board, holding by the first player, and a pawn, holding by last player. Finally, tutor told them that the winner team would receive a gift. Hearing this, all children yielded loudly to express their excitement and interesting.

This phase is the second chance to deliver knowledge to children. And a very important teaching materials here was the color board. Different from the first time knowledge delivery through practice of those musical instruments, the second time is theory delivery. So here the visual aids of color board could facilitate to learn faster, recall better, and inspire children's interest.

1.2.4 Fourth phase

After knowledge explanation and game rules instruction, the experiment arrived the last phase: playing the board game. Children participated the game team by team, each team has played in total four rounds until the first team won the game in the fifth round.

In the first round, the game started with the first team (N.1, N.2, N.3), and they finished the first question card successfully and it was a good start, but they were not able to move their blur prawn more forward. Especially, N.2. was a little bit sorry with his teammates since he was not able to memorize the correct musical instruments. The second group behaved better than the first group and they moved forward their red pawn two steps and they felt happily after their round; The third group lost their round without any movement of their yellow pawn but they did not show a sad face; The last group had the same progress with the second team under some other children's help.

In the second round, the first team did not make any progress because they made one mistake of the three requested colors on the question card, which resulted their failure

of the whole question card. Seeing the slowly progress made by all teams, the Italian tutor decided to changed the rules of the game by moving the same numbers of steps with the numbers of colors requested on the card. The second group started their second round following the new rules. During their game, Shybo lighted up red because of noise made by other children, which resulted the failure of the second team even they had not finished their time. The interruption of the game by noise happened also when other teams were playing, so the tutor emphasized again to all the children that they should keep quiet when other children were playing, in addition, with the guilty to the second group, the rest children agreed on tutor's suggestions to give the second group another chance to finish their last color before the interruption. Without other children making noise, the third group and the fourth group both played well and made more progress compared to past.

In the third round, children became more and more enjoyed in the game and the playing team cooperated better and better. Both the first and the second team made a huge progress in this round, and they were happy with their achievement. Especially the second group, they had a superiority compared to other teams after this round. Also the third and the fourth team performed better compared to past, but they were still very nervous during the game and very often, they forgot to move their pawns.

In the fourth round, the first group behaved well as before, and with the help of players from the second team, they made a huge progress. The second group was the most outstanding team in this round, they left only one step to the terminus after this round. Their individual performance was excellent, for instance, N.4 responded very fast and saved a lot of time on picking card and read questions for her team players; N.5 remembered always clearly the sound-color associations so that they did not waste time on lighting up wrong colors; Also N.6 often put his hand on the pawn so that he would not forgot to move it. All these great performance, together with other children's help lead to their huge achievement. As for the third team and the last team, they were still trying to catch up the first and the second team's progress, and they also enjoyed more in this round than before by helping each other a lot.

In the last round, the first team not only caught up five steps behind the second, but also reached the terminus within one minute and won the game. They were extremely happy and N.2. kept yielding to tutor that the first team won the game. In this case, the second team had no chance to be the winner even they left just one step, and they felt a little bit sad and regretted.

This phase has showed some difficulties for children at the beginning. For instance, in the first round playing of the first team, the second question card required children to make Shybo light up orange, blue, and red, however, the second player, N.2 tried his best but was not able to memorize the associated musical instruments. In fact, most children have such troubles. Hence, after the first team finished their round, the tutor decided to review all the musical instrument with respect to five colors, and it was found that every children was more familiar with the colors and musical instruments that they had experienced during the training, but had less memory of other colors and musical instruments. After the revision with tutor, the rest teams performed better than the first, mainly, the second players of each team played faster.

During this phase, it was also obvious that children enjoyed the game a lot. They laughed loudly very often, for instance, when red color was requested, they would shout loudly to Shybo and laughed together. Another example was that the second team was so happy with their lead position during the game that they celebrated by jumping, laughing, yielding, and clapping hands.

This phase was the second chance that children interacted with Shybo. Compared with the second phase, this phase requested more capabilities of children, such as: situation understanding, team work, balance between competition and cooperation and so on. At the same time, some knowledge were acquired by children, for instance, they had better and deeper understanding of Shybo's functionality to associate colors with sound, especially, the concepts of red colors representing big noises and the realization of self-volume control were generated.

1.2.5 Results and Evaluation limitations

The evaluation of the project (performed by Lupetti) was carried out to provide useful insight regarding both perceived usefulness of the robot that is crucial for product acceptance and the experimental compatibility with educational context and the existing practices which determine the way potential users give meanings to and apply the proposed solution relating to their values. The data collection used for evaluation was performed both on parents to gather their attitude with the experiment through a questionnaire and on children according both a video footage of the play test for subsequent observation and a self-report data about their experiences using three different tools: an after experience questionnaire inspired by GodSpeed Questionnaire (Bartneck, C et al., 2009), an Again and Again tables (Read, J.C., MacFarlane,S., 2006) and a Difficult-meter (Read, J.C., MacFarlane,S., 2006).

The GodSpeed Questionnaire is a method for standardized measurement of human robot interaction. It is meant to provide data that can be compared among different studies, and includes five consistent questionnaires to facilitate robot developers to monitor their progress with respect to five key concepts in Human Robot Interaction field: anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety. The five concepts are evaluated on semantic differential scales and can be further developed by psychologists to add new concepts where it appears necessary. The main characteristics of the five concepts are presented in couples of opponents:

Anthropomorphism concept includes five couples of opponents, which are: Fake and Natural, Machinelike and Humanlike, Unconscious and Conscious, Artificial and Lifelike, Moving Rigidly and Moving Elegantly;

Animacy concept includes five couples of opponents, which are: Dead and Alive, Stagnant and Live, Mechanical and Organism, Artificial and Lifelike, Inert and Interact;

Likeability includes five couples of opponents: Dislike and Like, Unfriendly and Friendly, Unkind and Kind, Unpleasant and Pleasant, Awful and Nice;

Perceived Intelligence includes: Incompetent and Competent, Ignorant and Knowledgeable, Irresponsible and Responsible, Unintelligent and Intelligent, Foolish and Sensible;

Perceived Safety includes: Anxious and Relax, Calm and Agitated, Quiescent and Surprised;

In this project, the questionnaire were designed with respect with GodSpeed Questionnaire with six questions relating to aspects of robot in terms of educational effect, children's likeability, interesting interaction, and so on. Each question had five different categories, including "not at all, not so much, maybe, yes, and absolutely yes". The first three questions submitted to parents revealed a general agreement toward robot's purpose, appropriateness, and interest in robot's trainability. For instance, the first question, relating to the purpose of the project, asked if the project related to promoting children's motivation and reasoning, and half of the parents said that it was relevant, two thought that it was very relevant, only one parent affirmed that it was not relevant at all. The second question was about the appropriateness of using robot for such purpose, and parents were even more positive: ten out of twelve had positive opinion, among which two had absolutely yes solution, and only one had extremely negative opinion. The third question, regarding the interesting of this trainability robot, eight parents thought yes and one thought absolutely yes, while two said that it might be interesting and one said not so much. The rest three questions were about some

specific aspects of the project I, including robot's likeability, learning potential, and suitability for school activities, and the agreement decreased slightly comparing the first three questions. For instance, Question number four, parents gave very positive feedback regard with children's likeability of the robot and willingness to play with it, and ten out of twelve were positive, and none was negative. On the contrary, for the fifth question, parents were asked if they thought children may learn from observing robot's reaction with respect to color-sound associations, and half of the parents believed yes and two thought absolutely yes, but three answers were totally negative. Instead, when parents were asked question number six if they would allow their children to attend such class that involved a robot in a game with rules and purposes described above, parents answer showed a slightly different from question number five, namely, there were just four positive answers, another four stated that maybe they would allow, and the rest four expressed a negative answer.
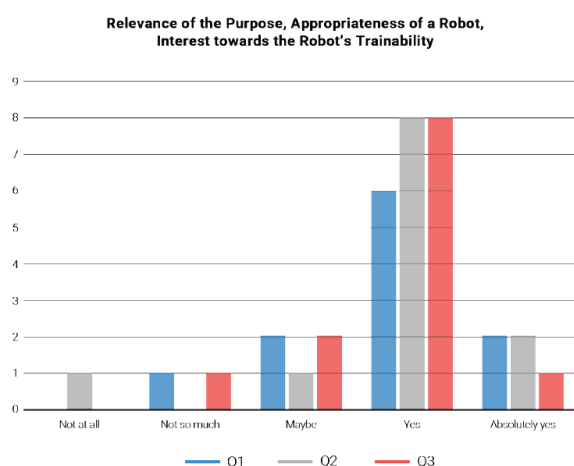
Table 1.1 Parent's answers to the first three questions about the robot's purpose, appropriateness, and interest toward the robot's trainability. The list of numbers on the vertical axis of the graphs indicates the number of parents (Lupetti et al., 2017)

Then an evaluation of the robot's appearance through a picture on a semantic-differential scale was asked to parents. This test included eight couples of opposite adjectives, and these couples were extracted from the Godspeed questionnaires set. These questions were asked to assess the likeability and suitability of the robot for children. For each of these two attributes of robot, three categories were created on the scale of evaluation from 1 to 5. For instance, for likeability, the three categories were appeal (with couples of adjectives: dislike or like), beauty (awful or nice), and friendliness (unfriendly or friendly); and for suitability, the three categories were simplicity (complex or simple), appropriate for children (inappropriate for children or appropriate for children), and safety (unsafe or safe). Generally speaking, the result for both likeability and suitability received positive feedback and the mean values of the

result was higher than 4.4. Particularly, the evaluation or robot's appropriateness was 5 for all parents, which means every parent considers it and appropriate for children. However, for the other aspects, parents had different opinion, for instance, on parent rated Shybo as almost awful (he rated it 2 with 1=awful and 5=nice). These results suggested in parents opinion the robot's appearance was satisfied in terms of likeability and suitability for chidren.

Likeability of the Robot, Opinion about the Learning Potential, Attitude towards this Robot used in a class
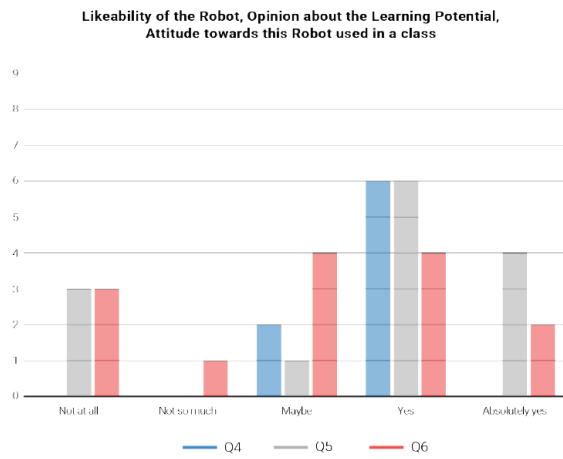
Table 1.2 Parents opinions to the last three questions about robot's likeability, learning potential, and suitability for school activities.

Table 1.3 Means(M) and Standard devations (SD) of six aspects of robot's appearance (Lupetti, et.al,. 2017)

Attribute	Descriptor's Category	M	SD
Likeability	Appeal	4.42	0.79
	Beauty	4.42	0.99
	Friendliness	4.67	0.65
Suitability	Simplicity	4.5	0.8
	Appropriateness	5	0
	Safety	4.42	0.79

Then an optional open question was asked to parents to understand their potential attitudes with Shybo and the proposed activity. Seven out of twelve parents answered this questions and a five of them expressed a positive attitude, and for the rest two comments, one pointed out the activity with robot reached half of the results but with

double effort compare to normal ways, and the other one warned that the robot, as a toy for children, had to be improved on anti-interference ability in order to be applied in class activities.

Table 1.4 Parents open answers about Shybo and the activity

Parent's Number	Comment
1	This game can improve children's observation and reaction ability
2	I really agree that kids can study something at play and all of kids would like to play with Shybo
4	Really like those type of games (game with rules)
5	Its really good for introvert children
7	I hope there are more chance for kids to attend this activity
9	Half of the results with the double of effort, and students should study basic classroom knowledge
11	Good toys and Shybo need to keep on improving and add the anti-interference ability, if not it is just suitable for home play

The questionnaire aimed to investigate the factors affect the role of robot considering social acceptance and societal impact in human-robot interaction field. Instead the analysis of playtest aimed to observe aspects of both usability and user experiences, namely to evaluate the factors affecting both playful learning and emotional experience of users. *The self-report questionnaire's results were excluded from the evaluation due to non-reliability. In fact, the evaluation aspects were too abstract for children and the the questionnaire forms were submitted to children in group rather than to individuals, hence, all the answers were the same.* As for other tools, that is the Again and Again table and the Difficultometer, *did not proved highly differential results*. For instance, all children said that they would like to do all the phases of the activity again except one said maybe he would like to do the color-sound associated phase. In order to understand children's opinion of the difficulties, the difficultometer was designed on the scale of 1 to 3, with meaning of 3 very difficult and 1 difficult. The results of mean values and standard deviations of different phases proved that all children thought the first phase was very easy, and for other three phases, while the difficulty level increased compared to first phase for children, the dispersion of opinion (stand deviation) also increased. Especially the last two parts, training the robot was considered difficult by two children and very difficult by one, and even more difficult resulted in playing games, where three rated it as the third level of difficulty, that is very difficult and one rated value one, namely difficult.

Table 1.5 Means and standard deviations of children's rating about difficulty of main activities phases

Phase	M	SD
Play musical instruments, create groups of similar sounds	1.17	0.58
Deciding a colour to associate with the sounds of the group	1.5	1.17
Train the robot by making sounds	2.17	1.46
Playing the game	2.83	1.64

With the limitations of the evaluation results from above tools, videos of the experiment became a crucial knowledge source. Video recording creates powerful affordances in terms of both breadth and depth, such as the ability to rewind rich details or to see multiple participant perspectives concurrently, and moment-to-moment interactional record, that traditional qualitative research methods generally do not afford (Kay E. Ramey, et al., 2016).

The whole activity was video recorded using an action camera, mounted on a tripod.

It lasted for 1.5 hours, were equally divided into 5 parts, and it did not included the preliminary part of welcoming children in the room and the final part of filling the questionnaire. In the preliminary analysis, the video footage was edited into a list of procedures and coded using Boris (Friard, O.; Gamba, M., 2016), a free and open-source software for video-coding and live observations. The coding excluded the transition and preliminary procedures (1,2,3,5,11,14,15).

According to the recording, a series of behaviors that frequently repeated were very interested for the assess objectives. These behaviors were in total 14 behaviors and were coded as stated event or point event according to the time duration, where state event referred to the behaviors that prolonged in time, such as smiling or verbal interaction, while point event represented behaviors with limit length, such as jumping. In addition, these behaviors were reported into two categories in terms of sample size of the children who had such behaviors, namely, group behavior or at least one. And the behaviors are divided into positive and negative according to the activity's valence they manifest (see Table 1.7).

Table 1.6 Sequences of activities that characterized the playtest with children

Step	Video Sequence	Description
1	00:00/00:01 (video 1)	Children are welcomed in the conference room of the school
2	00:01/00:35 (video 1)	Each child is invited to take one musical instrument from the front table
3	00:35/01:55 (video 1)	One child at the time is invited to play his/her musical instrument while the other listen
4	01:55/06:01 (video 1)	Children are invited to find sounds similar to the one of their instrument and to make groups of two or three children
5	06:01/08:18 (video 1)	Each group play the instruments again and select a colour, picking a coloured paper card
6	08:18/11:30 (video 1)	The tutor shows a short video that illustrates the functioning of Shybo
7	11:30/15:20 (video 1)	The tutor introduces Shybo to children
8	15:20/21:55 (video 1)	The tutor demonstrates live how to train Shybo
9	00:00/13:00 (video 2)	Each group, one by one, is invited to train Shybo by recording sounds and associating them with colours. During this action one child manage Shybo while another plays an instrument
10	13:00/18:58 (video 2)	After each group trained Shybo, the tutor switches Shybo in play mode and ask for children to play the instrument again. If the robot lights up in the colours associated during the training, it is working
11	18:58/21:56 (video 2)	Children are invited to leave the instruments on the front table, where they found them
12	00:00/04:17 (video 3)	The tutor introduces to children a small paper board of colours and explains briefly what are primary, secondary and complementary colours. She also asks questions to verify that children are understanding
13	04:17/05:51 (video 3)	The tutor introduces a board game that can be played with Shybo. She also explains the rules of the game, especially regarding the game cards and how to move ahead on the table
14	05:51/13:48 (video 3)	Children are divided randomly into four groups, and each group receive a pawn
15	13:48/16:31 (video 3)	The game is set up on the table
16	16:31/21:59 (video 3)	The game starts
17	00:00/20:10 (video 4)	The game goes on
18	20:10/21:57 (video 4)	The game ends when a group arrive at the last box of the board game

The output of the video coding, namely plot graphs, used the different phases on X-axis, and on Y-axis, the percentage of events length in each phase for state event and unites of events per minute for point event. The plot graphs displayed children's overall feeling of the experiment and also some different responses among various phases. For instance, in Table 1.8, the general trend of four main group behaviors (smiling, focused, concentrated, and silence) proved that children were overall engaged in the experiment. In addition, the general level of focalization was over 90% for almost all steps, and the reason that falling of focalization in step 12 was found in the video was that the robot distracted children from tutors.

Table 1.7 the list of behaviors emerging from the video-coding observation

Name	Event Type	Description	Reference Sample	Valence
Jumping	Point event	At least one child is jumping in a joyful and excited way.	At least one	Positive
Smiling	State event	Children are overall smiling, there is a joyful atmosphere.	Group behaviour	Positive
Laughing	Point event	At least one child is audibly laughing.	At least one	Positive
Wow	Point event	At least one child express surprise by saying "wooow".	At least one	Positive
Focused	State event	Children are overall focused on the activity, they look at it, stay close to the tutor A and respond promptly.	Group behaviour	Positive
Concentrated	State event	Children have a serious and concentrated face while following the activity.	Group behaviour	Positive
Asking questions	State event	At least one child ask questions related to the activity.	At least one	Positive
Silence	State event	When required by the activity, children keep silence.	Group behaviour	Positive
Verbal interaction	State event	Children are overall discussing, answering tutor's questions and commenting.	Group behaviour	Positive
Distracted	State event	At least one child is not focused on the activity, look at something else.	At least one	Negative
Moving around	State event	At least one child is not focused on the activity and move away from the tutor's position.	At least one	Negative
Instruments noise	State event	At least one child plays instruments while it is not required by the activity.	At least one	Negative
Scratching head	Point event	At least one child is scratching its head because he/she does not know what to do.	At least one	Negative
Bored	State event	At least one child is low reactive, the face is serious and the body is relaxed.	At least one	Negative

By looking at Table 1.8, the level of smiling decreased dramatically in phase 8,9, and 10, but compensated by the rising of concentration and silence, because they were paying attention to tutor's explanation and the robot was sensitive to the sound. While by looking at Table 1.9, in phase 8 and 9, some problem existed, and children's distraction and boring increased because of the mistake that one tutor did not properly connect Shybo to the software used to perform training, and in addition, the training activity involved children at turns resulting a decrease of excitement and rose of boring of children who were waiting.

Table 1.8 the trend of the overall group's behaviors
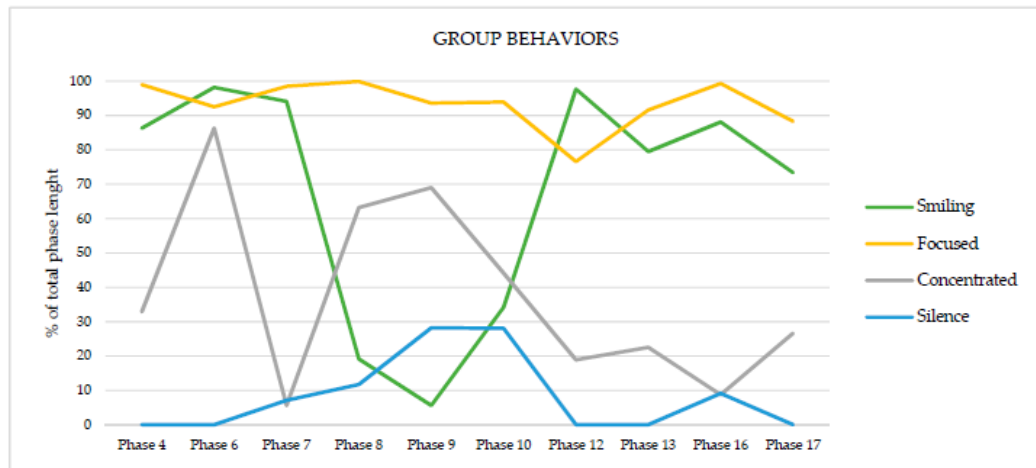
Table 1.9 the trend of behaviors manifested by at least one children
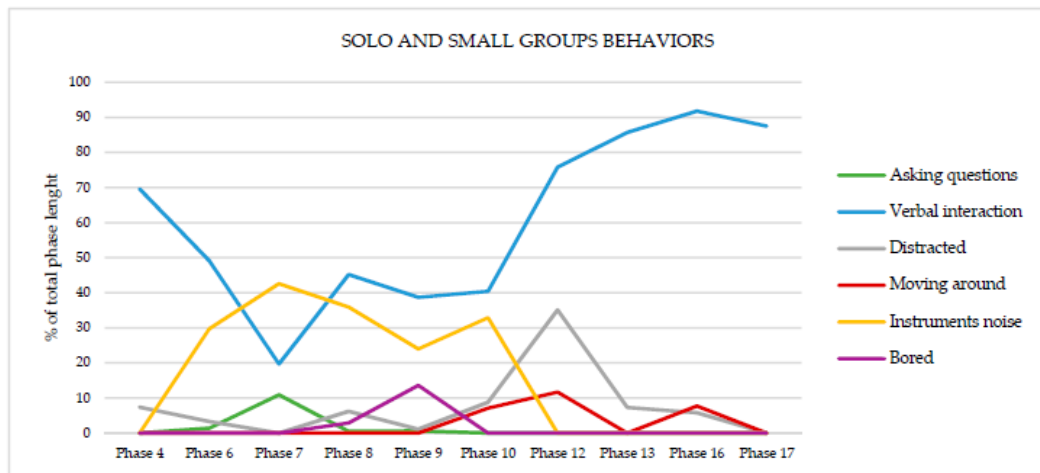
By looking at Table 1.10, the behaviors of jumping rise dramatically in final phase of the experiment, moving from an average of 0.9 events/minute to 5.61 events/minute. Another important point event is "wow" which mostly happened when new elements were introduced, such as the robot or game elements. The behavior of scratching head occurred only in one phase when children started to play the game, a boy (N.2) was entrusted of finding the right instruments to play and started to scratch his head manifesting a difficulty, which proved that he forgot the association between colors and musical instruments.

Table 1.10 frequency of four point events in one minute range

POINT EVENTS FREQUENCY
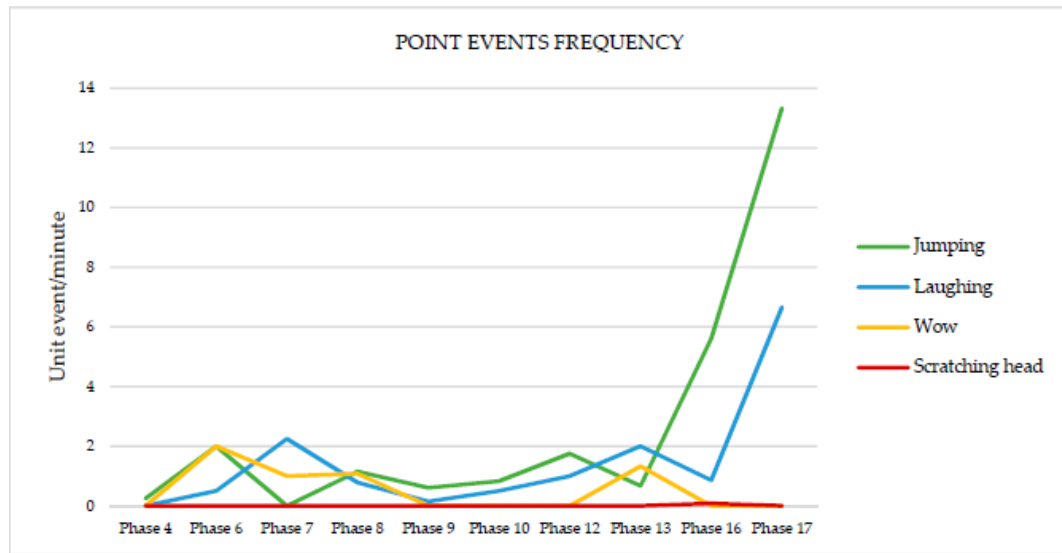
Limitations

The original evaluation of the project allowed getting feedback on the overall validity of the project, on the robot and the playful learning experience. However, some limitations exist and affect the robustness of conclusions.

Firstly, the absence of a complete transcription and translation in English of children's comments, which would have been extremely useful to obtain a better understanding of children's reactions and their natural attitude to being involved in an experiment; Secondly, the table 1.7 provided a limited quality to categorize children's behaviors, for instance, some other behaviors needs to be included (eg. Talking, which is different from children's verbal interaction, and it means children were discussing something neither related to the robot nor to the experiment), and the valence category is not valid for a few behaviors, such as jumping (not always a positive valence, for some children's jumping with no intention, it should divided into negative). Thirdly, for the results of plot graphs, the trends and frequency of several behaviors displayed children's perception of robot and experiment for each phase, but this quantitative analysis is not a rigid model to have a definite conclusion or to give some proposals to improve some weakness of the experiment, for instance, in Table 1.8, the level of concentration is not so interest here due to one child's face is natural serious, hence, this performance indicator was low quality for our objective. Last but not least, the analysis was not based on knowing individual difference, which means, for each participants in this small sample, different individual's extrinsic actions might related to similar vision of their intrinsic phycology, or vice versa, due to their different characteristics, level of

knowledge, capability of understanding, etc. So it is not proper to apply the same standardization on all the participants, but an individual analysis about their engagement or perception would be essential and valid. Given these limitations, a further analysis was carried out in Chapter 2 and Chapter 3.

Chapter 2

Knowledge acquisition

An analysis of users' behaviors based on video-recordings can be a very laborious activity (Bartneck et al, 2009), above all for studies carried out with groups of children in the wild, whose relevance is more and more addressed in human-robot interaction research. Thus an alternative approach for conducting this study, in relation to the experiment, was proposed, with the aims of reducing some of the natural limitations of these analyses and providing a framework to facilitate knowledge identification and structuring (Lupetti, et al.,2018).

This methodological approach has been used in several different contexts in which non-quantitative informative elements have to be structured to generate knowledge and to use formalized expressions of knowledge (above all cognitive maps and multi-criteria models) to facilitate decision and action.

This approach was implemented in this case for the experiment evaluation and validation, as well as to get feedback on the overall validity of the project (social robot and playful learning experience), and to propose a reference structure for organizing new experiments and stimulating new ideas and activities in this design process. It may be seen both as a proposal of a new analysis framework for the Human Robot Interaction field, when social robots are finalized to promote the children social engagement, and as a methodological proposal of knowledge acquisition, treatment and use, when several different   knowledge sources have to be synthesized.

The first section describes the first phase of the knowledge structuring process and includes the analysis of the videos, with the main difficulties (sometimes children cover the others, or speak at the same time, or are far from the camera, but often clearly express their points of view by their body gestures), and how a complete transcription and translation in English of the children's not only verbal expressions was made.

The second section describes a preliminary analysis of the transcription, in relation to the main topics that are proposed in literature. Then a wholly described structure of the conceptual model, which the previous analysis has generated, is described in the third section.

2.1 Video transcription

Video uncovers a wide range of interactional modalities; people use talk, gesture, gaze, body position, facial expression, movement, and material objects to exchange ideas and information (Goodwin, 2013; Hall, 1999). A video transcription of actions (Ramey et al., 2016) can capture the complexity of these dynamics and then can facilitate the understanding of the different interactions.

The first phase of the knowledge acquisition and structuring process was activated by means of repeated visualizations of the video recordings and the analysis of some critical parts of the videos with Maria Luce Lupetti, who designed the experiment and who played a role as an actor in the system for the current study. Video offers an open invitation to the researcher to look beyond the spoken word and find meaning from other dimensions of participants' activities. To create a transcript of the video, the first question is "what to transcribe?". It implies consequential choices about which phenomena merit representation by cueing a specific lens on what happens. Transcribing words exclusively can obscure all other interactional phenomena. The selection of lens of activities consists with the activities in Table 1.6. The development of detailed transcripts considered not just a sequential of verbal and nonverbal interactional phenomena, but also the interpretation of facial expressions, body movements, gaze and specific attention, gesture and pointing, tone and inflection, and engagement with material objects.

A detailed transcription has to overcome some difficulties in the video analysis. For instance, it was sometimes difficult to identify which child was speaking because some children covered the others or some of them were too far from the camera. In addition, the voices of so young children were quite similar and it was difficult to distinguish who was speaking, when they were not in the face of the camera. A specific difficulty was due to the similar appearance (the same height and hairstyle) and voice of two Chinese boys. It was difficult to distinguish them, unless seeing their face or number. Another difficulty happened in the translation phase. In Chinese, there is no difference between "he/she/his/her" and "it/its" in oral speaking, so an accurate translation is difficult when children refer to the robot using personal pronoun. Last but not least, the

transcription of the individual participant's behavior was made complicated for the contemporary presence of multiple and different activities, voices and expressions, at the same moment.

Considering these difficulties, the second question became "how to understand and transcribe all these elements?" Some specific procedures were implemented to reduce each difficulty. Firstly, I cut the parts containing individual child's voice and I played each of these parts for several times to have a clear identification of each child's timbre. Then, when some children covered others or some of them were too far from the camera, the verbal interaction was transcript on the base of the children's timbres. When different activities were overlapping, repeated visualizations, strictly oriented to a single participant and his/her activities were used as a lens to focalize individual behaviors. Finally, the personal pronoun the children used to refer to the robot was translated in "he" or "it" according to my understanding of the situation and children's perception.

The result was a transcription (see annex 1) that included a translation of the verbal expressions and a description of the facial expressions and behaviors of the actors' (twelve children, their parents, the Chinese and Italian tutors and a photographer). All the verbal expressions were included in the double quotation marks following the speaker, and some adjective or adverb were used to describe speakers' facial expressions, tones and body movements. Moreover, the comments (such as some situation explanations, according to participant's behavior or facial expression, correction of misspoke, etc.) were included in the brackets.

2.2 Preliminary analysis: application of five factors

The text of the video transcription was analysed the first time in order to verify if some specific themes, which are suggested in literature, can be consistent with this situation. They are animacy, anthropomorphism, likeability, perceived safety, and perceived intelligence, which were proposed to evaluate Human Robot Interaction (Bartneck et al., 2009) by means of five sets of related factors.

The consistency of these themes and their factors with this specific child-related robot application was tested by means of a structured reading of the text to identify elements in relation to the five sets of factors. Some themes were recognized as not being consistent with the context, because above all oriented toward analysing adults in interaction with robots in production processes.

The factors that describe some impressions of a robot, in relation to the concept of anthropomorphism are: Natural, Humanlike, Conscious, Lifelike, as the opposite of artificial, and Moving elegantly (and not rigidly). Some of them are recognized (and underlined and put in brackets) in this sequence of the transcription.

One child said:" It is just like the robots you see in TV."
N1 said :"but he cannot talk with us."
Tutor: "he could use his expression to talk with you" (Natural)
Tutor:" But if you talk too loud, it will get scared, and in this case, it would turned into red."
Two children said: "it is shy." (Conscious)

The children's perception of the robot as an animated being is central, in this experiment. The small robot does not seem a machine, but it is not humanlike, or rather, it seems an expressive, colored and shy mushroom. Therefore, anthropomorphism is not too consistent with the context and therefore this theme is not interesting.

There are several factors in relation to perceived safety, Relaxed as opposite of Anxious, Calm and Quiescent. There are some ambiguity in the interpretation of these factors. It could be "My perception of safety, in relation to the robot, is high if it is not so agitated", but also "My perception of safety in relation to the robot is high if I feel relaxed, not anxious". In addition, the perceived safety, in this case is totally reached, for the nature of the robot that is perceived as similar to the calm and relaxed robots they see on TV. Perceived safety is not so important for children who interact with a small and cute robot.

Several factors are proposed in relation to the theme animacy (Alive, Lively, Organic, Lifelike, Interactive and Responsive). The first four are always present in the transcription, because the children's perception of the robot as an animated being is central. The last two are more interesting, but they are more related to the concept of likeability, of a social robot in an education context, than to the animacy.

The theme perceived intelligence and the related factors (Competent, Knowledgeable, Responsible, Intelligent and Sensible) are more consisted with a context of robot-serving. In our context, the intelligence of the robot is more related to the theme likeability, for the nature of the context and the technological and human actors.

In general, the voices that are proposed in literature to rate the impressions in relation to the themes are not independent. An example is the theme likeability, where the first

voice (Dislike-Like) indicates the level of likeability and the other four voices (Friendly, Kind, Pleasant, Nice) try to explain how the expressed likeability can be described. A likeable robot can be described as pleasant or nice, but they are substantially synonyms. Friendly is a different and interesting characteristic. Others may be identified (such as familiarity) above all in relation to the concept of fun and enjoyment.

Not so different is the aspect perceived intelligence, where one voice indicates the level of intelligence and the other four try to describe the nature of the robot intelligence, but at the same time the likeability of a social robot that is Responsible, Competent and Sensible. And some voices of the theme animacy (above all Interactive and Responsive) express both perceived intelligence and likeability They can be analyzed together with some others that contribute to the likeability of the robot, the most interesting and attractive for children characteristic of the robot.

Therefore, we could start the analysis of the children' behaviors with the aid of some voices from animacy and likeability, in order to clearly define the role of this theme in this situation.

Meanwhile, some other themes were identified in the transcription. For instance, some possible risks and problems for future experiments, the usability of the robot in education contexts were recognized as an important aspect, etc. An explanation with example is proposed in these extracts from the transcription, with some comments that are underlined and in brackets.

*N1:"yiiii, there is a camera!" (An unkown technology, without any previous anticipation of its role, may generate **children's distraction**)*

*N7, holding his harmonica and asking :"How to perform it" (we can see later in the video that N7 was **so interested** in his harmonica that sometimes he went away from the table and played it.   This kind of noise (inappropriate for this experiment) produced interruptions. **Possible risks: time consuming** and lost attention).*

Children were making noise trying to sing following the video music *(The video music can generate a lack of attention and concentration.Risk effect: **Children's distraction**).*

*The Chinese tutor explained to the children that:"Before Shaybo was sleeping, so we could try again."(Something was wrong in the experiment, but a low quality of tutoring can **generate** children's limited understanding or **confusion**)*

*Tutor explained to the children what Maria said:"so now we changed the rules, if you see three colors on the question card, you can move three steps."(A change of the game rules, during the game, caused huge **complexity of the game**)*

Another new introduced themes are: Emothion that create action and children's reactions and their different profiles. The former one refers the evidence of children's emotions, extracting from their facial experesson, voice tone, either generated by robots or experiment, while the latter one refers children's different attitudes and reactions on same element during the experiment define different profiles, such as curiousness, competence, active, passive. An explanation with example is proposed in these extracts from the transcription, with some comments that are underlined and in brackets.
Evidence related to Children's emotion that create actions:

Children were making noise of exciting and surprising:(ahhhh,ohhh something like that.) and during the turning on the video, they said: "yiiii, what happened? Ahh, the light is too strong. Yiiiii, where it disappeared.ahhhh it appeared!" Children were making noise trying to sing following the video music.   (Children's emotions caused by the experiment environment. From their surprise and exciting tone, we know now they are in positive mood and willing to engage.)

However children still focus on scaring Shambo so they thrummed table together playing with their instruments. (Children become conscious of the nature of their interaction with the robot)

And children were surprised by the process that Shambo change colors and record the sound, so they said:"It is so amazing."(This shows children's likeability and acceptability from their surprise emotions and tones of yielding, also the usability and intelligence is the reason why the robot is widely accepted.

Other children seem like wait for too long, so they said" hurry up, " and they beat the table a lot. (Positive emotions shows that Children are all concentrated in the training procedure, which at least proved Shybo can attract children).

Evidence related to children's different reaction and profiles:

N10 said to N7 :" you need to blow it with your mouth." (different competence of Children, this kind of different competence has the effect of children's attention on the experiment, we can see later in the video that N7 is so interested in his harmonica that some times he went away from the table and played it, and some times this kind of inappropriate noise is also an interruption of this experiment that requires a low-level noise for our robot.)

Lupetti: "but before we need to tell them if there is too much noise, it get scared". Tutor:" ok."N5 child: "it is scared." (child who understands the situation, probably understands English). Children: (yielding loudly)"ahhhhhh, ehhhhhhhh." (at this moment also the others understand and express their appreciation of the new knowledge) (Different children's profile, here N5 can be considered a negative profile since his understanding of English may cause some not exact result of the experiment. Ie. He can give some expected reaction or emotion which however is not the real one.)

N3 child:"let me try" (confident profile) and he played his instrument, the cymbals.(N3 is another positive profile, which is confident and actively participate).

*N1 noticed the camera and said:"look there is a camera."
N1 again said loudly :"Look, there is a camera." And more children turned around and watched at the camera. And Chinese Tutor said: "the camera was used to record all of us." (Here N1 is another profile which is very curious).*

*N10 said:"don't worry."
N10 said:"let's start."
(N10 is one of the tallest among all children, and her characteristics is always more calm down than others. And tutor pay attention to her opinion a lot.)*

Together with these new elements identified, a new group of concepts that are more applicable to evaluate children robot interaction in a wild educational context is generated, that is: *Animacy, likeability, Emotions that create reaction, children reactions and there different profiles, problems and possible risks for the experiment.* These elements can be useful to test the experiment results and, at the same time, to describe the specific context in which the experiment developed. While considering children's expressions and reactions to some situations, different profiles of children

can be identified and used to describe the actors of this experiment. Confidence or hesitation, curiosity or passivity are different reactions that should be analyzed. Problems, which may affect the participants' emotion and behavior, and potential risks for similar experiments may appear, even if the experiment is well designed. The satisfaction level of the experiment could be studied by means of both the acceptability of the robot as a source of fun, in specific steps of the experiment and in relation to some actors and their different profiles, and the presence of problems and potential risks for similar experiments.

2.3 Tree evaluation model

The result of first analysis applying aspects of questionnaire (introduced in chapter 1.2.5) was that some voices in relation to the theme Animacy and Likeability, together with new introduced aspects (emotions that create actions, children's reactions and their different profiles, usability in terms of the acceptability of the experiment, problems and risks for future experiment) could be considered consistent with the experiment context, and the nature of Shybo, a small robot with the aspect of a mushroom and a very limited animacy. A conceptual model can synthesize these elements and orient a new analysis, together with the clear perception that the children were different and knowing their age could be less important than identifying their different profiles of engagement in the experiment.

A tree (see figure 2.1) allows a wholly described structure of the conceptual model, where two are the main aspects in consideration: Usability of the experiment in other experimental contexts and in educational practice, and Likeability, aspect which includes the quality elements of the interaction between children and robot. The leaves are not clearly defined, they are only an inspiration from the voices and evidence in 2.1 to give a suggestion of what should study a new analysis of the knowledge elements that can be inferred from the video reporting analysis.

On the top level of the tree model: the general aim of the experiment was to verify if a group of Chinese children can enjoy interacting with this robot, i.e. if their engagement may be recognized and the robot can come to light their emotions, in addition, to test the quality of the experiment which means to evaluate though video-based multi-criteria method if this children-robot interaction can be introduced in other context.

On the middle level: the two main branches were the aspects that had to be taken into consideration: Likeability, a general aspect that includes the quality elements of the interaction between children and a robot and Usability of the experiment which consider both the acceptability of the experiment in other context and the elements that can generate risks, such as unknown technology, here it refers to the camera, not the robot. The satisfaction level of the experiment could be studied by means of both the acceptability of the robot as a source of fun, in specific steps of the experiment and in relation to some actors and their different roles/attitudes, and the presence of problems and potential risks for similar experiments.
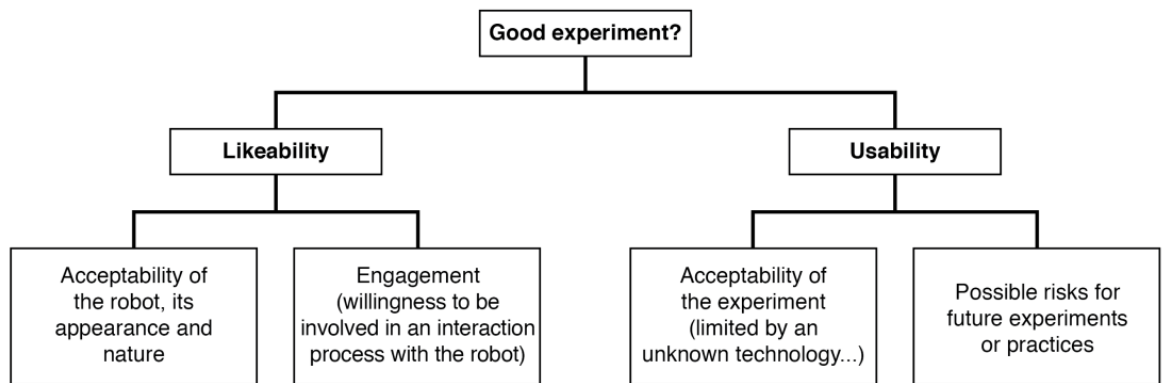
Figure 2.1 Conceptual model

The bottom lever: the voices of Likeability and Usability are extracted from topics analyzed in 2.2, which are: *Animacy and anthropomorphism, Likeability, Emotions that create actions, Children's reactions, Risks and problems*. The branch of children's likeability of the robot is composed by concepts extracted from topic Animacy (where the general appearance of robots may cause positive or negative first impression due to satisfaction or non-satisfaction of children's expectations, at the end it may affect the children's likeability of robots), children's acceptability of the robot,their willingness to be involved in the interaction, and their different reactions to the performance of the robot, respectfully extracted from the topic Likeability, Emotions that create action and Children's reactions. On the other side, the branch of Usability of the experiment in similar educational context is composed by the elements extracted from the problems and risks topic, Children's different reaction during the experiment in terms of different role and capabilities, and the topic of usability in terms of children's acceptability and participation in the experiment.

In order to improve and validate the logical tree that is used to structure an evaluation model, we adopted a cognitive mapping approach, to analyze the Video and its specific parts, that is described in the next chapter.

Chapter 3

Knowledge structuring and use

Conducting experiments with children in a process that involves technological components, in relation to organizational, educational and cognitive dimensions, can be very laborious. Therefore, the aims of the experiment, and then of this evaluation, have to be clearly defined.

The main aim of the analyzed experiment was to verify if a group of Chinese children can enjoy interacting with this robot, i.e. if their engagement may be recognized and the robot can come to light their emotions. Therefore, the question becomes "how we could test the acceptability of the robot as a source of fun in this kind of experiment?" And this could be combined with another question "can an analysis grid for this experiment become general and be proposed for other experiments in different contexts?" And then" how the context can condition the results of an experiment and how it should be analyzed and included in the analysis grid?"

Therefore, this evaluation phase should be oriented not only to help knowledge identification and structuring, in relation to the acceptability of this robot as a source of fun, but also to provide a pathway to act on it.

The adopted methodological approach is an integrated process of cognitive mapping and multicriteria modelling. This approach has been widely applied in the Operation Research field to facilitate decision making when several actors are involved, some complexities and uncertainties are present and the problem is not clearly formulated.

The first section describes the logic of a process of knowledge acquisition and use, by means of a cognitive mapping approach.

The last section presents some results, in terms of children's profiles of different role and level of capability, a list of possible risks and problems during future experiments, and the multicriteria evaluation model defined by the elements structured in the cognitive maps.

in terms of child's profiles, risk analysis and multicriteria evaluation model.

3.1 Knowledge structuring

The methodology consists of a structured process of knowledge acquisition and use to facilitate decision, in this case in relation to a design process. A cognitive mapping tool was proposed in (Norese, 1995 and Buffa et al., 1996) in interaction with a model structuring system. They resulted particularly useful to identify specific problem elements and to analyse them, in order to clarify the nature of the problem or to activate and orient new investigation or analysis activities (Norese, 1996; Norese and Salassa, 2014). The process of knowledge acquisition and structuring is built by two phases, the first to acquire informative elements (collecting data and documents, or eliciting individual perspectives or problem representations by means of interviews to the actors, participation management, video typing of collective events or experiments, ….) and the second to identify and analyse possible elements of knowledge and to represent them by means of logical networks or cognitive maps. The steps of this second phase are five: Statement structuring and coding, Topic evidencing, Concept identification, Concept analysis and Cognitive mapping.

Step1. Statement structuring and coding
All the informative elements, which are available from sources that can be of different nature and reliability, have to be structured in a formal representation (tables, texts or data bases).Then the informative elements have to be distinguished in statements, which are related to a specific theme or subject, and coded in relation to their main nature and to the related theme, if it is clear enough. At this time, a statement is transformed in an information cell.
The identification of the themes is not so easy at the start. Sometimes the themes can be suggested from the situation or the literature, in other cases their identification is slow and uncertain at the start and becomes easier when new sources clearly suggest a theme that was present in some previously analysed documents, but not sufficiently clear to be indicated. Some identified themes can be eliminated or changed and only at

the end, when all the documents have been analysed, all the statements can be labelled in relation to the related theme.

Step 2. Topic evidencing

When the documentation analysis is completed, all the information cells (with the information pertaining to their nature and the proponent source) in relation to logically connected themes are listed together to create a cluster in relation to a specific topic. A topic is a whole theme, in this case, but it may be a kind of expression (criticisms, or suggestions, or wishes, …), or the point of view of an actor, when a different list is proposed with statements of the same nature or of the same proponent.

Step 3. Concept identification

The central concept that is expressed for each listed and coded statement has to be pointed out, to synthesize the statement with a few words. If a statement seems to express more than one concept, it is possible that the previous structuring results have to be re-analysed and the statement divided into two or more different statements. A second possibility is that the real meaning of the informative element is not sufficiently clear and the equivocal interpretation is a sign of this uncertainty. If several statements express, with partially different words, the exact same concept, only one version of it should be used, without changing the meaning and indicating all the proponent sources.

Step 4. Concept analysis

At this point, the acquired informative elements are organized and synthesized in concept clusters, which are related to specific topics and labelled in terms of nature of the concept and proponent source(s). The concepts of a cluster are analysed together to identify recurring concepts, contradictions or anomalies, and to identify the logical relationships that link the concepts.

Step 5. Cognitive mapping

A representation network can be created for each cluster, i.e. a graph with arches representing relationships and nodes concepts. A cognitive mapping approach analyses the logical relationships (cause-effect, complementarities, concordance, divergence and so on) between the concepts and between the networks that share some concepts. It facilitates visualization and formulation of the problem, which is desegregated into some sub-problems that have to be specifically analysed to produce the essential

elements for the decision, and/or the activation of new investigation or operation. It can give information about the contribution of each participant to the exploration of a problem and to the creation of a collective cognitive structure (Damart, 2008), or it can synthesize in maps a process of expertise elicitation, exploration and structuring (Norese and Ostanello, 1988; Bana e Costa et al., 2002), using each map as a communication space and a component of the intervention result documentation.

Cognitive mapping can be combined with a model structuring approach in an iterative process that facilitates both knowledge structuring and its formal representation and use.

3.1.1 Cognitive mapping

The last step of knowledge structuring process is cognitive mapping process which allows the visualization concepts relationships, such as causality, influence, explanation, complementarity, contradiction and so on. A cognitive map is a network in which nodes indicate concepts ad arcs denote relationships between concepts. Each concept can be associated with a proposing source and characterized by a typology, and the relationships have to be coded in order to distinguish their meanings (Huff, Jenkins, 2002; Eden, 2004; Norese and Salassa, 2014).

Two kinds of map were created, the first to represent the different types of behavior of the children (and then to identify their profiles), and the second to cluster concepts in order to analytically express the component elements of Likeability and Usability. The knowledge elements (actions, words, expressions of the involved actors such as surprise, excitement, or disappointment) that were acquired from the video analysis were included in nodes, as a textual copy of the expressed words or descriptions of the actions and physical expressions. The associated actor's code, the experiment phase and a conceptual synthesis of the words were indicated in brackets near the words in the nodes.

Relationships between the nodes can be identified in order to reduce the complexity that can be present in a concept (multiple meanings, ambiguity and difficult distinction between apparent or real contradiction of other concepts), to facilitate a clear, structured and transparent interpretation. In this case, only three kinds of relationship were used: Cause-effect, In agreement with and Contradiction.

3.1.2 Map of behaviors of children

For the map of children's behaviors, maps for specific individual child (who was either rich in words or physical actions) with different characteristics and behaviors and maps for a group of children (either with similar reactions or involved in some steps at the same time such as cooperation to play board game) were created (see annex 2). A map that synthesis the different verval expressions of child N.1 is presented in Figure 3.2.

All the verbal expressions of N.1 are included in the box and the scenery that these words were expressed are included near the box. These verbal expressions were copied from the transcript of the video footage, among all the words with same central concept, only one sentence was chose, the bold letter with number at the end of those expressions inside box means the times of the sentence was repeated by the involved character, namely N.10. The theme into which several expressions converge is included in the box connecting to the expressions by dash dot lines, here referring to "knowledgeable and facilitator". The evidence were composed by a series of her answers to other children, for instance, her explaining to N.7 who had no idea how to perform his musical instrument in the first phase; and her answer to N.1 who was very curious about Shybo's functionality and kept asking the same question, which may interrupt other children training the robot; and her correction to N.3 when he made mistake on choosing the musical instrument when playing the board game. The three outstanding screen shot (helping child with difficulties, stopping other's interruption of the experiment, correcting other's mistake) formalized N.10's image of knowledgeable and facilitator.

A map of all children's physical expressions and verbal expressions is illustrated in Figure 3.3 in order to have a visualization about the capability of each children in Phase IV (Playing board game). The better understanding of each participants' capability is crucial to reduce some limitations and problems during the both the phase of design and organization of the activity, and in addition to facilitate the creation of different states of each criteria in multicriteria model.

The statements coded by the number of children are extracted from children's verbal expressions and behaviors during playing the board game to better indicate children's status during the whole phase of game playing, in particular, the words expressed children's different status are colored in red and the explanations of some children's behaviors or words are included in the brackets in italics to avoid ambiguity or clarify the context of the statements.
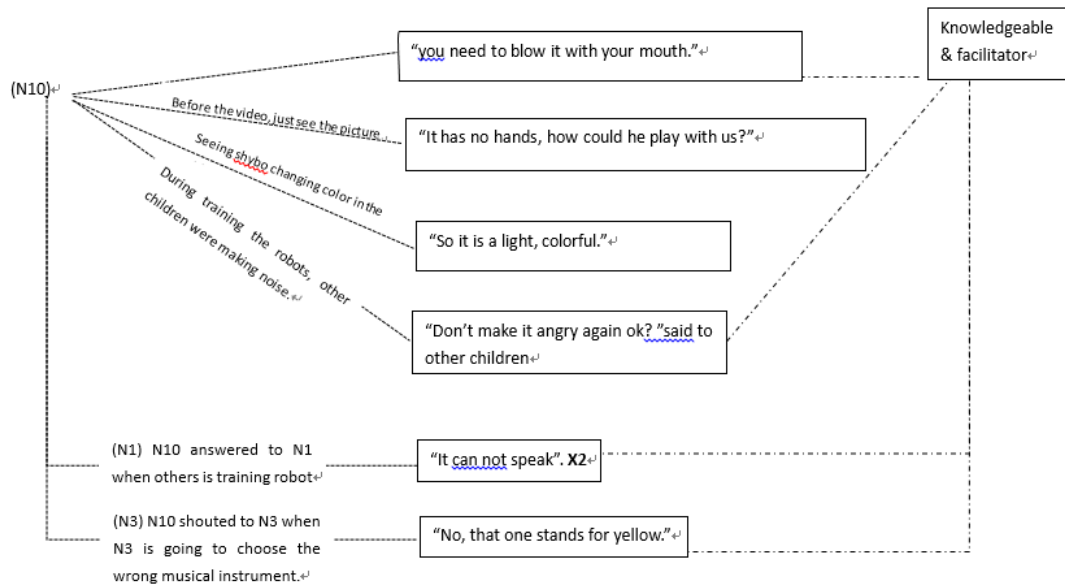
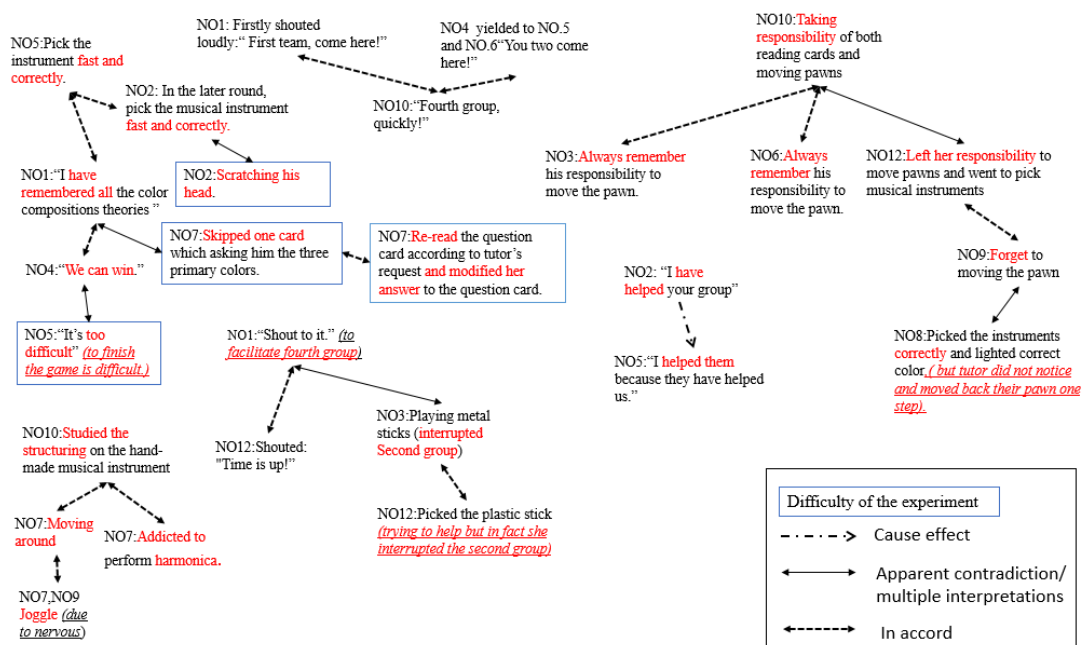**Figure 3.2 Verbal expressions of a child in the experiment**

Figure 3.3 Merging of children's physical expressions and verbal expressions in Phase IV

The difficulty of the experiment could be proved by some of the statements included in the blue box, in which, three sources of the difficulties were founded, the first one is

too many musical instruments involved in the game, the second is some difficult questions on the question card, and last one is each team's slow-progress in just one minute. The evidence of first difficulty was found by NO2's uncommon behavior, scratching his head. The evidence of the second difficulties was found by NO7's skipping question card and re-read the questions; And the last difficulties was found by NO5's verbal expression happened when he saw three team failed in one minute without making any progress. The last difficulty was solved by the tutor later by changing game rules, hence, we could think of the impact level as low. For the problems coming from difficult questions, even in the video we found that tutor has little inspection on children's answer of the question card, but the four children responsible to answer the question card are N1, N4, N10, N7, in which N7, and N10 got problems seeing the map, N1, N4 we can infer that they had no difficulties considering their performance in the procedure of color theory in Phase III. Since the problem only affected two children and happened just two times, we may consider the impact is in medium level. And for the difficulty caused by too many musical instruments, it could be considered to have big impact on the quality of the experiment since it affected in total 4 children (N2, N5, N7, N11), in which two out of four children (N2, N5) overcame the difficulty after the tutor repeat the color-musical instrument associations, but N7 and N11 had this problem till the end of the experiment. Hence, the difficulty related to color and musical instrument associations is considered as the main source of complexity of the experiment in risk analysis in Chapter 3.

While considering children's expressions and reactions to some situations, different profiles of children can be identified and used to describe the actors of this experiment. Confidence or hesitation, curiosity or passivity are different reactions that should be analyzed. Problems, which may affect the participants emotion and behavior, and potential risks for similar experiments may appear, even if the experiment is well designed.

3.1.3 Map of concepts clusters

Likeability Aspect

The cognitive map generated the idea of Likeability of the robot by merging the concepts of children's empathy of robot with regard to the appearance of the robot, the curiosity about the nature of the robot and their willingness to interact with the robot. Three clusters with respect to those three concepts composed the cognitive map. The

first cluster is empathy, which refers children's interpretation of Shybo' scared state. Three relationship were found among these statements. First of all, some children interpreted the scared state of the robot as "Scared" due to tutor's explanation, however, they did not just stayed at that level but to interpret the reaction of the robot in a quasi-physical way (by saying "the robot lays down its mushroom hat"). Some children's explanation can be considered as in accord with the above, since that both the interpretation of "scard" and "shy", also the close naming of the dices as Shybo's baby all reflect an imagine of a small and exquisite thing that could cause a sense of protectiveness in children's feeling. However, some contradiction way of interpretation was also found where children use vocabulary with different emotion, such as angry, or unhappy and these words create an image of an object with strong feeling that could cause a sense of seriousness.
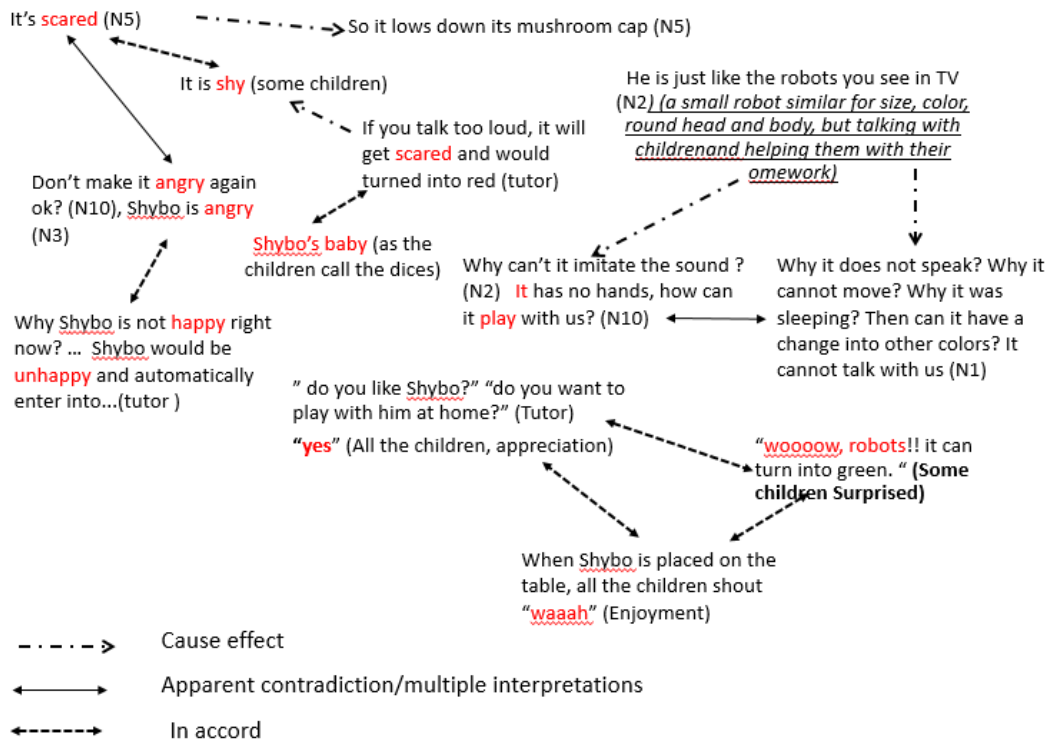

Figure 3.5 The cognitive map on the Likeability aspect of the robot

The second cluster is curiousness about the general appearance and nature of the robot. The statements in this cluster are mainly children's questions about shybo compared to their expectations which is the robot they have seen on TV. The robot on TV is in

children's knowledge, hence, when seeing Shybo, a robot with similar appearance, children automatically expected similar functionality in their mind. The different attitudes to deal with such unsatisfied expectations reflect children's different behaviors, some of them ignore the difference between these two robots (Shybo and robot on TV) after the confirmation from tutor, while the others still insist on knowing the nature. Hence, children's conception behind these questions are different, on one hand, some children would like to know what Shybo can do and how it can do, on the other hand, the other children would like to understand why Shybo can not do like other robots (in their knowledge or satisfied their expectations) can. Considering the above reason, the relationship between two groups of questions are in conflict with each other. The last cluster is children's appreciation, surprise and enjoyment during the interaction. The evidence are composed by both children's directly verbal expression of appreciation and interjection word (wow, waah, etc). And they are in accord with each other in terms of children's positive perception to the robot.

Children's unconscious role evolution

Merging children's verbal expressions during the interaction, a transition of children's role as game went on was found (see figure3.6). Three transition stated composed the second cognitive map of children's unconscious changes on their role. At the very beginning, children followed tutor's instruction and asking questions before their actions, this state refers children as "Followers" in which no initiative action and all actions with regard to tutor's guidance; After one or two round of the board game, some children started to change their role as "Facilitators" with a few initiative actions in order to promote other children's progress, such as remind other group about time passing, comfort other children in unstable emotion, and help other groups to light up the robot either in word or in person; When parents were involved, another children's role appeared, the "Leader" of the experiment, where children started to guide their parents how to play the board game and correct the mistakes of parents. Hence, three clusters are generated with respect to these three states. The evidence of first cluster are selected from Phase II (Presentation of training) and Phase III (Introduction of game rules), and the nature of these questions put by children is to understand the situation caused by tutor's explanation, so two relationships (cause effect and in accord with) are generated among in this cluster. The second cluster is composed by statements copied from Phase IV (playing the board game) of the experiment, some children were very interested in the game so that they involved not just in their round, but also in other

group's round, and in addition, only standby waiting and watching the game could not satisfy their interest, so they started to participate in by helping others and at the same time, they felt the same feeling (such as nervousness, pity, excited, etc.) with the team involved. N10's solace to other children avoid further problems in good time. Hence, the nature of different children's behavior is the same to solve problems and promote the experiment progress. The evidence of last cluster are taken from the Phase IV (Parents involved). Two kinds of relationship link these statements, namely cause effect and in accord with. Two type of children's actions in terms of leadership were found in this phase, to actively correct parents' mistake or to passively give instructions which are activated either by seeing parents' erroneous execution or by parents' questions. However, the nature of children's behaviors are actually the same that is to explain, to instruct, and to organize.
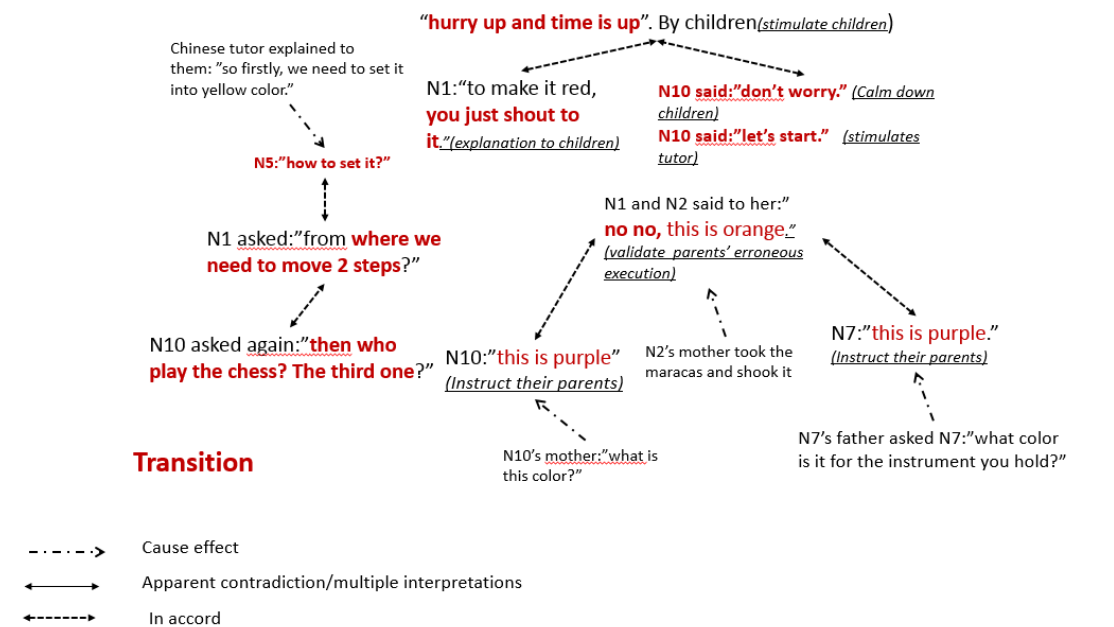
Figure3.6 The cognitive map on Children's unconscious changes on their role

Children's interest and enjoyment with respect to the experiment
Cognitive map of children's interest and enjoyment of the experiment (see figure3.7) is composed by children's physical and verbal interest and engagement in the experiment. The evidence are basically copied from three situations, the first is due to tutor's question of which children or group would like to try first, and in this case, all children's action by putting up hands and some children's verbal complaining of not being selected

are considered as evidence of children's willingness to participate in the experiment; The second is when children had no patience to wait anymore (wait for other group or wait for tutor), they expressed their agitation by beating the table or by saying let them try, and these expressions are evidence of children's extremely aspiration to be involved; The third is when they concerned other group's playing, this kind of anxiety is different from the first two cases in which children yawn for participation more, but here children expressed their interest in the experiment by concerning time passing and concentration on the experiment when other groups are involved. Hence, the relationship between two actions of "beat the table" in the second case and in the third case is multiple interpretations, namely the same action but with different natures.

Some statements in this cognitive map are related to other topics, such as Children's transition and problems and limitations of the usability. These two topics are illustrated in blue box in the cognitive map and they refer to the *cognitive map of children's unconscious role change* and *risks and problems analysis.*

The relationship of contradiction is found between N3 and a group of children, where all of them expressed their interest to start the game, but N3 was not so clear understanding the situation, because for him, the group that started first in Phase II was decided by tutor, and tutor did not clarify the first group to start in Phase IV yet, so it is understandable that he got this question; however, for the rest children, they automatically connected the sequence of team playing the game with the sequence of team number. Hence, the contradiction is in their perception of the situation.
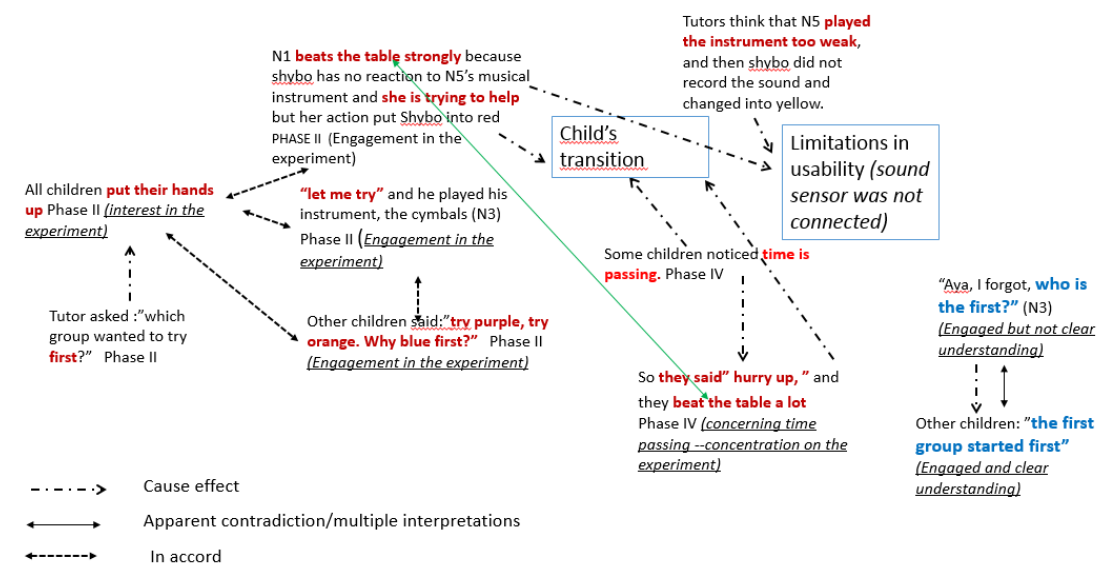

Figure3.7 Cognitive map of children's interest and enjoyment of the experiment

3.2 Knowledge analysis and use

This process of knowledge acquisition and use produced a sequence of results which have different practical implications. In the first section, different psychological profiles of the children were defined, when interacting with the robot in a playful context, and these profiles can be used to better define the role of robots in education (O'Keefe, 2016), and, at the same time, they facilitate the definition of a multicriteria evaluation model (Norese, 2016). The identification of some problems in section 2, during the experiment, stimulated a risk analysis and the elaboration of some risk control options, which could be useful in the design process. At the same time, these elements were used to evaluate the overall quality of the experiment. The last section synthesed all the concepts of knowledge obtained from the cognitive maps and risk matrix to formalize a multicriteria model with some suggested criteria which could be used to evaluate the children robot relationship.

. 3.2.1 Children's profiles

The interactions of the children with the robot, and in general with the experiment, resulted to be different among the children, both in the videos and in the structured syntheses of knowledge from the videos (the lists of actions and verbal or physical expressions of each child and the cognitive maps where these elements were logically connected to understand the meanings of some not so clear reactions).

There was no interaction between the children and the robot in the first and third phase, but it was possible to define some children's profile, for example, the children who helped others to learn how to play the musical instruments were considered experiment facilitators, and the children who answered tutor's questions related to color theory were considered as knowledgeable participant. While the second phase was different, and the descriptions of the impressions and actions of the children in this phase were used to facilitate the definition of the profiles, together with an analysis of the children's reactions to the game presentation and activation (see 3.2.1 mappings representing children's behaviors), to consider their active or passive attitudes of being involved and to involve their parents in the game (phases IV and V).

A first distinction was made between "strong" and "weak" children (see figure3.8 and figure3.9). A child who had clearly understood the process and had showed the capability of following and reacting was considered strong. Weak refers to those children who had difficulty in understanding the situation and the procedure (mental

weakness), but also limited engagement in the experiment, above all as a result of certain specific characteristics of a child, such as timidity or habitual lack of attention. Some children clearly understood everything and demonstrated acceptability and adaptability, others were full of curiosity about the nature of the robot that they wanted to know better, and also about other involved technologies. Some children asked questions and carefully organized their groups during the game.

The second distinction was between "active" and "non-active" (see figure3.8). Active means posing and answering questions, following tutor's instructions, understanding the situation, explicitly associating specific elements of the experiment with their previous experience. On the contrary, non-active refers to those children non initiatively following tutor's instructions, either due to some distraction or lack of interest, or even asking some questions not related to the experiment.

Figure3.8 children's reactions to the game presentation and activation
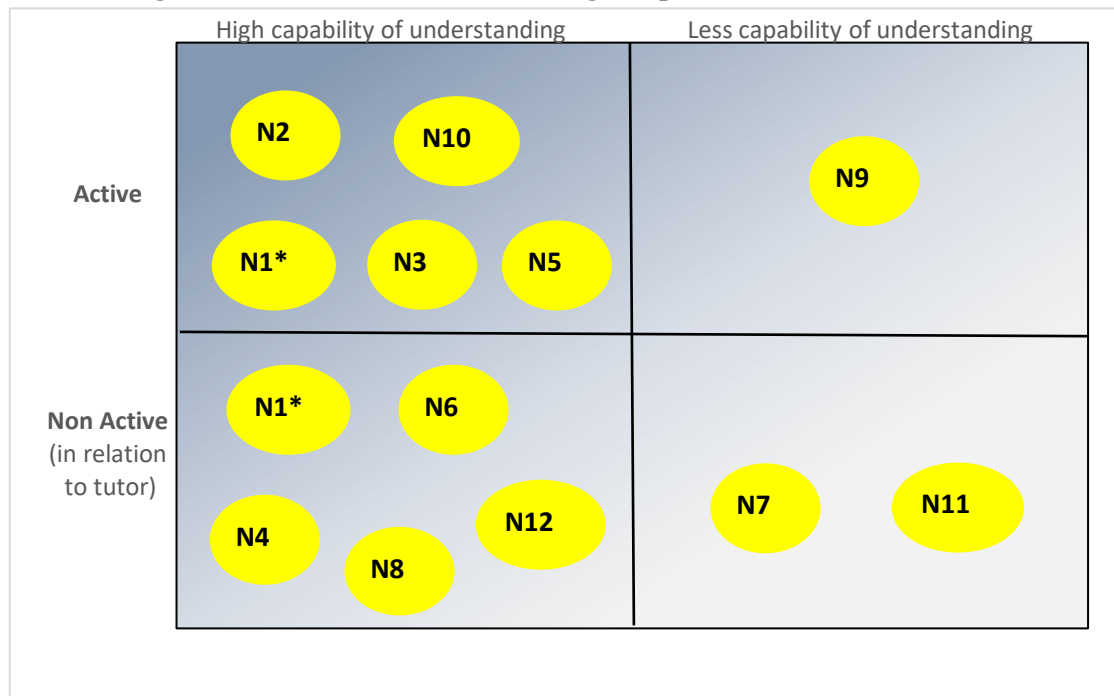
N1* showed her non active in relation to tutor by expressing verbally, (saying something with no relation to tutor's explanation.)

N6* expressed physically non active because he did not fully focus on tutor's explanation during the color theory introduction phase.

Considering children's involvement of the experiment, another distinction is between engaged and non-engaged (see figure3.9). Engaged means the capability of

unconsciously passing from a simple role to another more mature role: from the role of follower (participating in the game and sometimes asking questions) to the facilitator role (explaining things to others, verbally stimulating other children or a tutor, calming some others), and finally to the organizer role (organizing their groups well, instructing their parents or validating their parents' activity). Some children participated in the game but did not demonstrate any form of transition from one role to another. Only one child (No.7) participated in the game without showing any curiosity about the robot, game or experiment, and always focused attention on an unknown musical instrument.

Figure3.9 Children's reaction during the game

N10* sometimes is jumping around when other group is playing because of long procedure, but in her round, she is fully engaged.

From the figure above, N1 is one of the strong actor but full of curiosity, she wants to understand, but not always with respect to the experiment. And her relation with tutor is not so normal, we can say that N1 is not a so classical student, because she always ask the same questions for several times and seldom got acceptable answers or got answers immediately from tutor. She is more interested in everything present, for example, new elements and technology and curious about the nature of the robots such as, "I'd like to see the camera over there. ";"why it does not move? ;"why it does not

speak?";"how it can sleep?". In the fourth phase, N1 is a facilitator, she made her group well organized, to prepared in advance and to leave space for other groups during the game.

At the same time, N10 is another strong actor but different from N1. N10 could understand questions and situations and has strong acceptability and adaptability, when something is not clear for others, she is easily and evidently understanding the answer (Eg, her response to N1"it can not speak.".). Another thing we can see from the Cognitive map is that she is a facilitator in the first three phases. But one problem with this actor is that, when the procedure is too long, she is not able to pay attention totally, which could be seen in the phases 4, when other groups are playing, she is jumping around.

N2 is another Strong actor, but more important smart and focalization. There is no dispersion of him, always follow tutor's instruction and understanding the situation. Another important aspect we found on N2 is that he has a preliminary model of robot in his mind before watching the presentation video according to his words:" It is just like what you see in TV." Here TV is an important reference, in China, children may see robots in the TV advertisement, for example, there is one common robot in TV, with round head and body, white color and it is small such that it can be put on the table, and it can talk with children and even help children with their homework questions. We can say the shape and dimension of Shybo is similar to the robot in TV, and the color is the same. Such kind of preliminary model also facilitate N2's acceptability of Shybo and inspires the function comparison in his mind between Shybo and the robot he saw in TV, which is the reason he asked:" why it can't imitate the sound it heard?"

On the opposite side, N7 is a relatively week candidate. Here, we consider two parallel level of weakness: the first level is weak in terms of mind, which means difficulty to understand the situation and the procedure; The second level of weak is in terms of participation of the experiment, which means less engaged or responded because of children's characteristic, such as shy. Here N7 is weak mainly in the first level. But she is also an less active candidate both with reference to tutor and to experiment, since she paid more attention to the harmonica, and in the fourth phases, he took the harmonica with him most of the time, on one hand, we may say sometimes he also facilitate other groups, but more important, he kind of interrupted other groups because of his more occupying the harmonica.

N12 is another candidate, she is not weak in related to the understanding, but has limit interaction with tutor. However, during the experiment, she showed more interesting to robots.

N4, and N8, they are not weak in understanding but less active with tutor because they are a little bit shy than others.

Table3.1 Engagement profiles

Children (coded name)	Engagement profiles
No.2, No.3, No.5, No.10, No.9*	Active in the interaction process with the tutors (in each phase of the experiment) and engaged in the game (phases IV and V)
No.1, No.6	Only engaged in the game
No.4, No.8, No.12, No.11*	Only participating in the game
No.7*	Distracted

The profiles of these children under same category were different from each other and, for these reasons, another distinction, which is synthesized in Table 3.1, was implemented. In this table, four categories of children are described in terms of their different types of behavior in the interaction process with the tutors and during the game. The star indicates a mixture of mental weakness and timidity, which was present in three of the twelve children.

3.2.2 Risk analysis

One of the main objective is to evaluate the quality of the experiment which could be affected by some risk factors we have talked about in Chapter 2.3, in addition, these factors, together with children's acceptability of the experiment, are considered as the most essential aspects to be analyzed of the usability of the experiment. Risk analysis is performed based on 4 internal sources (*Components caused time consuming, Components caused children's distraction, Components caused children's confusion, Complexity of the game*) that could cause risks during the experiment of which the evidence are concluded in 2.3, and one external sources, that is *technical risks*. For each sources of the risk, a risk breakdown structure is applied for each procedure of the experiment evaluating the "impact-possibility" ratio and the residual risk ratio by taking

some imitation actions. A risk description of different sources and respected imitation actions are listed in Table3.1.

The risks listed were observed from video recording, and some of them could be easily avoided by taking mitigation actions, such as the mistake of tutor's taking off sound sensor, the confusion caused by quality of presentation video could be compensated up by tutor's explanation, and children's curiosity about unknown technology (refers to the camera, and photographing process, etc) could be explained well in advance. However, some of the risks affect the quality of the experiment very much, for example, the complexity of the experiment: the experiment is really complex not only for children, but also for the parents, including musical sounds, color theory, training, question card and cooperation of team work, we can see there are a lot chaos when parents involved to play the game. It has been noticed in the video that the tutor changed game rules one time during the game, the intent of the tutor was trying to promote children's playing by letting them to move more steps in one minute, however, this low quality control could cause other problems, such as time consuming on explaining to children the new rules, and children need time to adapt themselves to new rules (in particular, some children (N9 for instance) always to forgot to move more steps after applying new rules). Considering this, the design of all the experiment should try to reduce unnecessary complexity, for example, 12 musical instruments are necessary during the procedure of separating group and training robot, but it is not necessary to have all the 12 musical instruments during the game playing, this can not only cause confusing of some children's memory, but also could divert children's attention from the game (for instance, it was observed in the video that N3,N10,N12 playing instruments leads to the failure of one group. However tutor's propose of rules to give that group another chance is good because in this case tutor became the interruption of interrupters.), actually, 5 instruments with respect to 5 different colors is totally enough here.

Another risk that affect the quality of the experiment a lot is the bad organization of children's position in some steps, in particular, two cases were observed: the first is during the color theory introduction, Children who stands closer to tutor could focus more than children stood further. Another cases is when introducing the game rules, tutor's movement usually near N3 to N6, so N10 to N12 can less focus, especially they are much closer to Shybo.

Table 3.1 Risk Description and Risk management

	Risk sources	Risk description	Mitigation action
Risks	Compents caused time consuming	Children have no idea how to perform the musical instruments.	Introduce to children the materials in advance
		low quality of tutoring: in some procedure, tutor's explaination were too long for some children.	Prepare tutoring contents in advance
		Spending time on explaining new game rules	Follow the same rule from the beginning to the end
	Tecnical Risk	Sound sensor were turned off during the training procedure	Check all elements before the experiment.
	Components caused children's distraction	Unknown technology : camera, photographor	Introduce to children in advance.
		Un familar musical instruments for children, like harmonica for N7	Introduce to children in advance
		Space were not well organized: children who were far from tutor are easily distracted by other staffs.	Better organize and promptly adjust children's space.
		Musical sounds in the presentation video	Delete musical sounds from video.
		low tutoring: too long explaination make some children boring.	Prepare tutoring contents in advance
	Complexity of experiment	Unecessary complex elements: too many musical instruments included in the game procedure	reduce the number of musical instruments during game.
		change of game rules during the game	Follow the same rule from the beginning to the end
	Components caused children's confusion	Low quality of tutoring: such as tutor's explanation of turned of sound sensor was that Shybo was sleeping.	Prepare tutoring contents in advance
		Space were not well organized:Shorter children can not see tutor's presentation clearly	Organize the space for each phases in advance and include a surpervisor during the experiment to control the position of children in case of disorder or bad organized
		Change of game rules duing the game	Follow the same rule from the beginning to the end
		Low quality of presentation video and limited tutoring during the video playing: some children could not understand Shybo's functionality.	Better and some detail explaination together with video presentation.

A sketch of children's position is showed below:
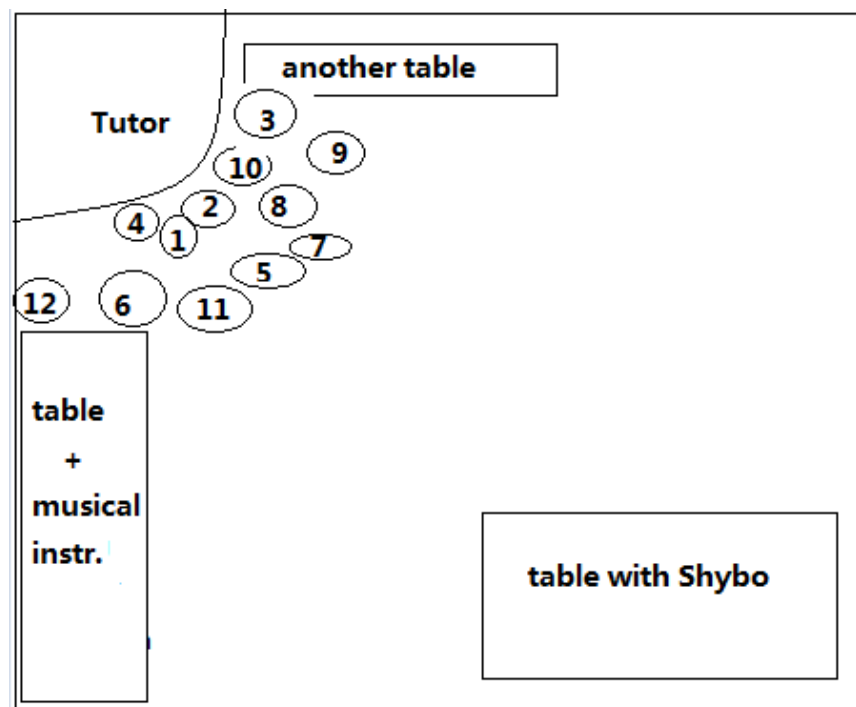
Figure3.10 the first case of bad organization of space (phase III-Introducing color theory)
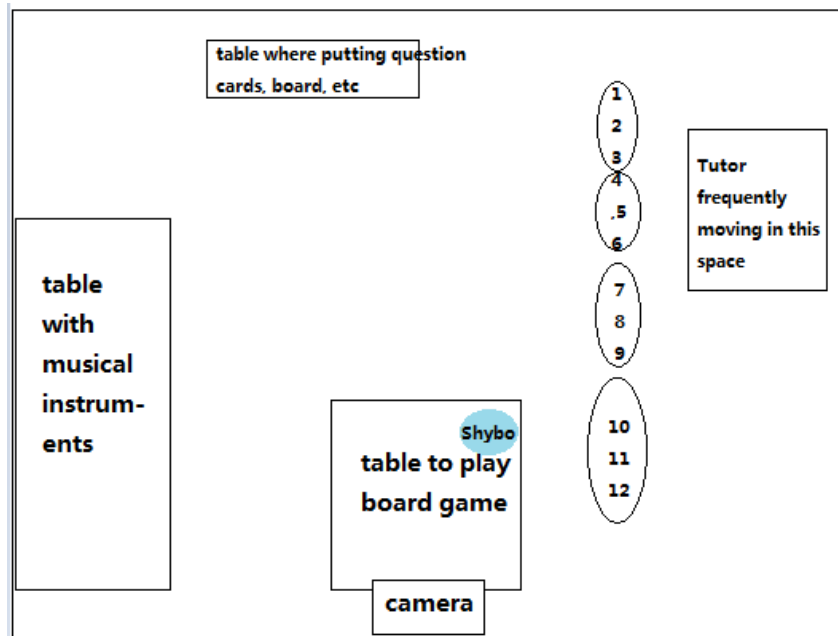
Figure3.11 the second case of bad organization of space (Phase III-Introducing game rules)

The effect of these risks and problems would affect the efficacy of the experiment and in addition affect children's perception of the robot, for example, the complexity of the

game may cause children's passive attitudes of the interaction with the robot, the time consuming factors may reduce some children's interest to be involved. Hence, a further analysis to evaluate the cons and pros, and the add-value of these mitigation actions on the improvement of experiment quality would provide useful knowledge to optimize risk control strategy and to facilitate the robot design and experiment elaboration.

3.2.3 Multicriteria model

Last step is to elaborate a multicriteria evaluation model by applying concepts acquired from cognitive mapping clusters into the tree model as criterion to fully enrich the elements of likeability and usability (see figure3.12). And for each criterion, the scale of that criterion is proposed.

Figure3.12. Structure of the multicriteria model
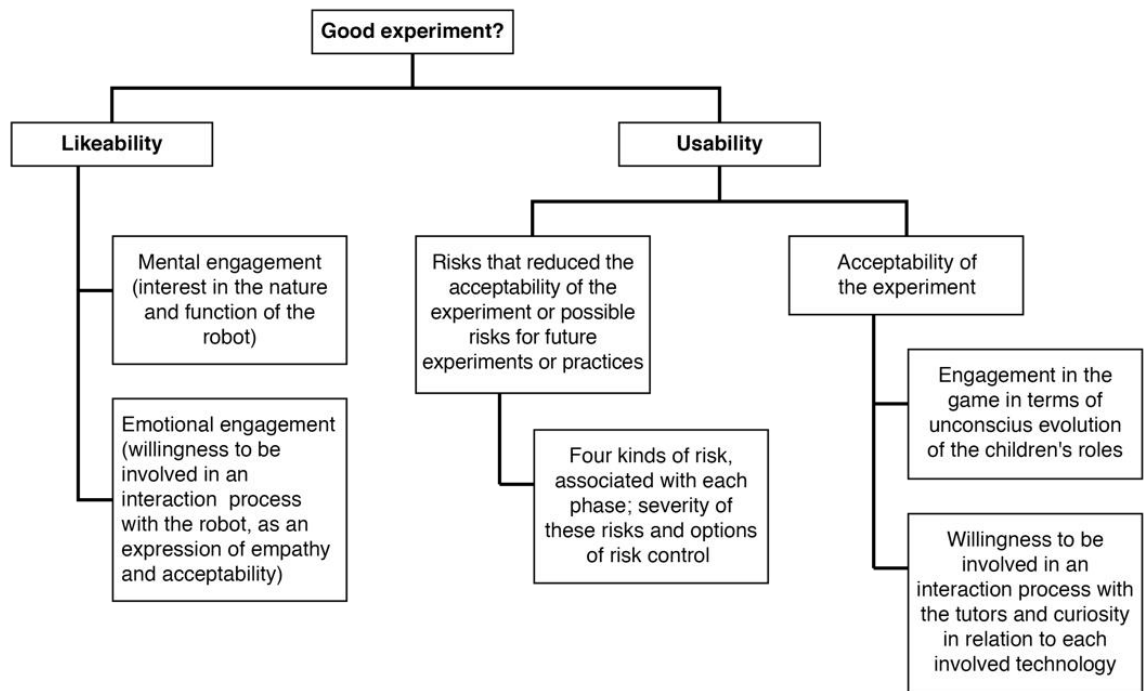
The analysis of the cognitive mapping of likeability of the robot produced a proposal of dealing with the Likeability of the robot aspect considering two different criteria, Mental engagement, in terms of percentage of children interested in the nature and functions of the robot, and Emotional engagement, which was expressed as the percentage of children that demonstrated a willingness to be involved in an interaction process with the robot, through expressions of empathy and acceptability.

The criterion of Emotional engagement considers the children's acceptability of the robot so that to be involved in the interaction, hence, a possibility to include two different attitude of children, Positive acceptability (which means children have positive attitude to accept the robot. And it includes children's different feeling during their interaction with robot, such as surprised, pleasant, and amazing.) and Negative acceptability (not just in terms of Shybo, but also those elements that related to other robots.).

Positive acceptability may include 3 different states: explicit appreciation, only enjoyment, and both enjoyment and explicit appreciation; The explicit appreciation are those words expressed by children, such as :

Tutor asked :"do you like Shybo?"

Children answered loudly:"yes"

Tutor asked :"do you want to play with it at home?"

Children answered again loudly :"yes" "

The enjoyment refers to children's expressions, feelings showed in the phases and in the interaction with robot, such as: children's smiling, laughing, and their words "wow". And last state is that children both showed explicit expression of their likeability and emerged their enjoyment.

The Negative acceptability includes three different states: Disregard, refusal, and fear. These states are used to describe that when the majority of participants are in this condition, and they express such kind of negative acceptability.

Again, the performance indicators could be proposed as the percentage of children in each state. To conclude, we may introduce several different level to evaluate children's Emotional engagement, for instance:

A **very high** level of engagement if at least 50% of the children express explicit appreciations (words) plus enjoyment (facial expressions, e.g. smiling, and approval sounds (wow, laughing);

A **high** level of engagement if at least 50% of the children express or appreciations or enjoyment;

A **low** level of engagement if some emotional acceptation is present in at least 30% of the children;

A **very low** level of engagement if at least 50% of the children express lack of interest (they produce background noise, jump around the room) and some emotional acceptation is present in less than 30% of the children;

Rejection of the robot if a majority of children express (apprehension, fear…) and some high or very high emotional acceptation present in less than 30% of the children.

In this experiment, it was observed that at the end of the game, all the children expressed their explicit appreciations by answering tutor's question"Do you like Shybo?" and "Do you want to play with it at home?", in addition the smilling and approval sounds were observed as group behavior which could reach always above 75%, and in some case above 90%. Hence, a very high level of emotional engagement condition was satisfied.

The scale of criterion *Mental engagement* consider the level of curiosity in relation to the nature of robot, hence, the possible two indicators we proposed here are: the number of different questions and the number of children who put questions. In this case, we have 7 different questions in terms of the nature and functionality of robot, and they are:

(N1:) Why it does not speak? Why it cannot move? Why it was sleeping? Then can it have a change into other colors? It cannot talk with us? (N10): It has no hands, how could he play with us? (N2): Why it cannot imitate the sound? The number of questions is enough, and these questions are very important. Another indicator is the number of children that put questions (in case 3 children), and those children are N1, N10, N2, among these three children, one of them ask questions very frequently. It seems that the number is limited but as we noticed in different children's profile, some of them is shy and won't initiatively put questions.

The Usability of the experiment in educational contexts aspect includes Acceptability of the experiment and control of the Risks that reduced the acceptability of the experiment or which could affect future experiments or practices. Acceptability dealt with two criteria: Engagement in the game, in terms of unconscious evolution of the children's roles, and acceptability, in terms of Willingness of the children to be involved in an interaction process with the tutors and curiosity in relation to each technology that could have played a role in the experiment. These criteria were expressed by the percentage of children, in particular, the criteria of engagement in terms of unconscious evolution could also be evaluated by the number of children's role-change with large span, for instance from interrupter to facilitator.

It could be observed from the cognitive mapping of Usability that at the start of some phases (such as to train Shybo), children's willingness to be involved is 100% (seeing the evidence that "all children put their hands up."), and for the unconscious evolution of children's role, which could be mainly concluded in Phase IV (Playing board game) and V (Playing game with parents), 5 out of 12 children changed their role to the facilitator or even leader when their parents involved, in particular, N7 who was evaluated as a weak profile (an interrupter and easily distracted in some phases) has facilitated parents' game by explaining to his father the associated color of one specific

instrument. Hence, even the percentage of children's unconscious evolution of their role is not so high, but with the great change of role of Number 7 and always majority expression of willingness of children, we might conclude that children's acceptability of the experiment was rather high.

The Risk aspect dealt with four criteria (Technical risks, Complexity of the experiment, Components that confused or distracted the children, Components that were time consuming) that were used to evaluate the severity of the different risks associated with each phase and the options of risk control that could be activated (see Chapter 3.3.2). This criteria could be expressed by the risk exposure, where if the risk exposure is below 30%, we could say that the risk of the experiment was controlled well and the effect of risk on experiment quality could be accepted; for a risk with risk exposure is between 30% to 60%, we may considered that the risk control is not enough and the effect of that risk on the experiment is critical; and for the risk exposure fallen into the range above 60%, we might criticize that the risk control is too limited and the quality of the experiment would be affected catastrophically.

The components of this model can be used separately to evaluate Likeability or Acceptability, or to evaluate the Risk component and its present or future impact. Another possible approach synthesizes all the components (and criteria) by means of a multicriteria method (Roy, 1996) that accepts both quantitative and qualitative data to generate evaluations. The method can be used to evaluate the overall quality of the experiment and compare it with other experiments, to compare the quality of the different phases, or to compare the overall or phase quality with a monitoring reference model, in order to use this information in the design process.

Conclusions

The research proposed a knowledge structuring approach applied in an observational experiment in an educational context involving children and a small robot. The evaluation was based on the transcription of the video recording of the experiment. Hence, the quality of the transcription was significant for the reliability and robustness of the evaluation results. The video has been reviewed by many times to reduce the limitations in terms of correctly understanding and translation all participants' verbal expressions, facial expressions, physical expressions and meaning behind. In case of multi participants being involved at the same time, an individual focalization has been performed in order to record all the movements and behaviors of all participants. In case that speakers are covered, far from the camera or standing with their back to camera, the identification of speakers referred to their different body shapes and timbres. The knowledge acquisition, structuring and using approach was based on three main steps, data collection in terms of the creation of video transcription, eliciting individual perspectives in terms of statement coding and concept analysis, problem representation by cognitive mapping in terms of cluster of concepts acquisition and concepts relationship identification.

The results of this search includes a risk analysis matrix and multi-criteria model. The evaluation model was elaborated by cognitive mapping method to structure the aspects that may affect a good children robot interaction experiment, together with several suggested scales to evaluate children's perception of the robot and the experiment. Several practical implications has been observed. The understanding of children's mental and emotional engagement has produced important knowledge of robot design in terms of the appearance, nature and function of the robot, while the identification of children's attitude during the interaction process can be considered as a crucial aspect of the experiment quality, in addition can affect the efficacy of the experiment.

Some risk factors were listed in the risk analysis section and they were considered as an important aspect affecting the quality of the experiment. Hence, a further analysis to study a risk mitigation plan and their actual value on improving the sustainability of the experiment would be an interesting and useful topic.

Appetndix1: Transcription of the Playtest

Tutor:" Today we are going to play a game. You can see there are 12 toys for you on the table, and now each of you can go and pick one."

Children:" Yes."(smiling and running to the toys).

Tutor: "Stand in line after picking your toys. What is the common ground of the toys you chose?"

Children: "they can make sounds."

T: "yes, they can make sounds."

All the children were testing their toys

N7 holding his harmonica and asking :"How to perform it"

N10 said to N7 :" you need to blow it with your mouth."

Tutor to Children Number7 : "put it by the side of your mouth."

Tutor to Lupetti: "could you please teach him how to play it?"

Tutor to all children: "among these toys, there are one to two toys that play similar sound. Ok N1 child, where are you? Ok, you play a sound(tutor talk to N1 child). Which child think he has the toy that could play similar sound with N1 child, please put up your hands."

N4 child put up her hands.

Tutor to N4: "ok, so you think you two have toys that play similar sound, right?"

N4: "very similar."

Tutor: "ok, then you two come here and stand together. Now N1 and N4 children have formed a group."

Children: (smiling).

Tutor: "then, where is Number 2 child? Could you please play your toys to make a sound? And which child think your toy have similar sound?"

Children: (testing their toys and playing sound).

Child N3 :(put up his hand).

Tutor asked N3 : "do you play similar sound to N2?"

N3:(play sound again).

Tutor asked N6 :":and you, do you play similar sound to N2?"

N6 :(play sound).

Tutor talked to N2, and N3,N6, "do you three play similar sound? Do you notice that all these three toys have metallic components, so that they play a metallic sound? Try again."

N2, and N3,N6 :(Play toys again one by one but have no idea if these sounds are similar).

Tutor to Lupetti: "they do not know they belong the same group."

Lupetti: "OK."

Tutor to N2: "then do you think which child play similar sound to you? "

Lupetti: "try another one."

Tutor asked N11 to play a sound, and asked all children:" whose toy play similar sound to N11 child?"

Tutor to N5: "do you play similar sound to N11? "

N5 played his toy.

The tutor asked to N10: "do you play similar sound to N11?"

N10 played her toy.

Tutor asked these three children again," do you three think you have toys that play similar sound?"

No answer from children, so tutor said," do you notice that all of your toys have an empty part, so this empty part could play a similar sound. Try again. So you three belong to the same group. Come here and stand together."

Tutor to all children: "ok, now let's move there a little bit since we don't have enough space here.Now these five children have already formed their groups, and we need to form group for the rest of children."

Tutor said to the N7:" try to play your toy."

Tutor to all children: "which child think he has a toy playing similar sound?"

N1 point at the child with clarinet (N9)and said, "her".

Then N9 played clarinet and formed group with the N7.

Tutor asked N8 to play a sound, and N1 pointed at N12 and said:" her." N12 played the sound and tutor asked:" are they similar? "N5 answered:"yes, the same." Then all childen answered:"yes."

Then tutor said: "ok, now N8 and N12 formed a group".

Tutor talked to the rest three children: "could you three please play again? Are they similar?"

Children: "yes , similar. N6 and N2 are similar."

Tutor: "each child has one or two group mate, if N6 and N2 formed a group, then who will be the group mate of N3?"

Tutor discuss something with Lupetti, which was not clear from video and children were playing their own toys.

Then tutor said, "so N2, N3 and N6 formed a group. And now everyone stand together with your group mate. "

Tutor:"now i have 5 color cards, what are these colors?"

Children: "red, orange, green ,blue, purple."

Tutor: "now each group need to choose a color, lets choose one by one. the first group, what color do you three choose?"

First group:" one said blue, one said green."

Tutor: "you three should agree."

First group: "one said green again and the other who said blue before said ok then green."

Tutor:"ok, then here is the green card. the second group, which color do you two choose?"

Second group said: "purple."

Tutor turn to the third group: "then what about you two?"

Third group:"one boy said orange, one girl said blue."

The tutor said: "you three belong the same group, you should agree."

Then the boy who said orange before said to his group mates :"then yellow, lets chose yellow.". And tutor asked the other two members, they both said yellow.

Tutor turn to the last two groups and said: "well, we let the girls to choose first, ok?"

Then one girl from another group yield, "all of them are girls."

So the tutor asked N7of the last group, "then you first, which color do you choose?"

N7 said: blue.

Tutor asked N9 of the fifth group":what about you?"

N9 said: "orange."

Tutor said: "you two discuss ok?"

N7 turn around and look at N9, and N9 thought a little bit and said: "then blue."

Tutor smiling and said :"then I give you blue card." And asked the last group," then you are the orange group, ok?" And the last group argreed and directly take the orange card.

At the same time, children from other groups were yielding the color:" yellow, purple." And another child said, "ah these two groups color are very similar to each other"(i can not tell which girl said this and which colors she is tallking about, but i guess the girl is from the purple group since the voice is quite similar.) And tutor answered to her :"yes , they are similar."

Then the tutor said to all the children: "now the color you hold can represent the toys you hold now".

And children started talking: one answered to the tutor yes. One said:" I have green"; one said: "i have green too". One said:" mine is yellow". One said:" orange". One said :"green".One said :"green", One said :"blue", One said :"purple". One said :"mine

is the same as yours". And they focused on their small conversations and did not listen to the tutor. Later the tutor said, "ok lets move there a little bit". And children moved back together.Tutor said:"then you all understand you can collect the color you have to the sound your toys could make, right?"

One child said: "abcde, "i think he did not follow the tutor and just said pinyin which are not related. And other children were playing their toys and making the sound.

Tutor said again: "Then you need to use the color card and the toys you have to play a game with a small robot."

Children asked in a curious mood: "is that it? "(pointing to the screen).   (first impression is nice)

Tutor said: "yes it is him, his name is Shybo."

Children:" Shybo."

N10 said: "he has no hands (Humanlike), so how could he play with us? (interactive)"

Tutor said: "we can watch a short video."

One child said: "oh, what is the video about?"

Tutor:" let's watch the video and to understand how Shybo could play. And during you watching, i would explain you how Shybo plays."

Excited children for the surprise (ahhhh,ohhh, something like that) and during the turning on the video ("yiiii, what happened? Ahhh, the light is too strong. Yiiiii, where it disappeared. ahhhh it appeared!"). Children were making noise trying to sing following the video music.

During the watching, children asked: "what does it mean?"

Tutor explained:"Shybo could hear the voice."

Children were making noise trying to sing following the video music.   (pleasant)

Tutor asked: "what happened? Is he feared?"

N10 watching and talking: "It is a light right? Ahh It is colorful. Yaaaa, it can change color.

N1 put up the orange color card and said:" he changed into this color."Other children said: "woooow, robots!! it can turn into green. "

N1said: "it can move or not? "

One child yield: "ahhhhhhh,woooooooow,Green."

Children yield every time when Shybo changed colors: "eiiiiiiiii, eiiiiiii."

N2:"It is just like the robots you see in TV."

N1 said: "why It does not move?"

When the video is almost finished, children yield again, and one said:" *I did not understand.*"

N1 said: "ahhh so it can not move!"

One said:" I understand!"

The video is finished and tutor said: "maybe some of you could not understand, but don't worry, i will explain how you can play with Shybo using your color cards and toys. Come here."

Children: "waaaah."

N1 :"yiiii, there is a camera!"

When Lupetti put Shybo on the table, all children yield together: "waaaaah." (pleasant)

Tutor said: "his name is Shybo. Not all robots have legs and can walk,(organism) his exceptional function is... "not waiting the tutor finished, N4 said: "it can change colors!"(conpetent) And tutor said:" Yes! It can change colors! You are very clever. And now our Italian tutor will teach you how to play with Shybo."

One child said:" Italy, pasta."

Children smiling and yielding: "pasta, pasta. I want to eat pasta."(kind, pleasant, friendly)

Tutor: "ok, silence, listen to me, has everyone formed a group?"

Children: "yes."

Tutor:" did each group have a color card?"

Children: "yes. Orange, blue, green, yellow."

Tutor: "then I will show you how to connect the color with the toys' sound. What is your name Number 5?"

N5: "Zhang Yiding".

Tutor:" Zhang Yiding child has chosen a snare drum. (Tutor beat the drum at the same time)And his group has chosen yellow card."

Lupetti asked tutor: "you are going to show them how to train it?"

Tutor:" yes."

Lupetti: "but first we need to tell them if there is too much noise, it get scared".

Tutor:" ok."

Children:" what does it mean?"

Tutor: "children, do you know how many colors does the rainbow have?"

Children:(speaking loudly) "7 colors."

Shybo get scared and turned into red and kept shaking.

Children: "red. Wow."

Tutor asked children: "what is it doing?"

N5 child: "it is scared." (child who understands the situation, probably understands English)

Children: (yielding loudly)"ahhhhhh, ehhhhhhhh." (at this moment also the others understand and express their appreciation of the new knowledge)

Tutor: "it is scared, right?"

N5: "it is scared".

Tutor: "what is its reaction if it get scared?"

N5:"it lowers its mashroom cap."

Tutor: "and its face turn into red, right?"

One child: "yes."

Children:"it is shy."

Tutor:"so you see, no group has the red color card."

Children: "yes , we have".(and they were trying to find some red colors on their cloth or on whatever staffs).

N2:" look, this is red."(he is holding the tie on the bass drum belonging to the girl N11 standing beside him).

Tutor: "yes, but you do not have red color card, right?"

Children: "no, no, we do not have red color card, we have green."

Tutor: did you find how to make it red?

Children:" we have no idea."

N1: "we scare it."

Tutor thrummed the table strongly and Shybo did not change into red. And Lupetti clapped her hands near the instrument measuring the intensity of the sound, then Shybo turned into red. And children were surprised by that and yielding: "wow, it got scared." One child:"let me try" and he played his instrument, the cymbals. *Another girl noticed the camera and said:"look there is a camera."* However children still focus on scaring Shybo so they thrummed table together playing with their instruments.

Chinese tutor said: did every notice that tutor Lupetti had clapped her hands and then Shybo turned into red? And why?"Children were yielding and some of them said:" because the sound is to strong." *The girl above again said loudly :"Look, there is a camera." And more children turned around and watched at the camera. And Chinese Tutor said: "the camera was used to record all of us."*

Then children started to thrum the table and play their instruments again to scare Shybo. And one of them noticed that the change of the measurement instrument and said,:"look, the sound became louder and louder." Tutor said:"You see, he always got scared, right? But if he always got scared, maybe he do not want to play with you any more." N1 who saw the camera) said :"but he can not talk with us.".Tutor:"he could use his expression to talk with you.   But if you talk too loud, it will get scared, and in which case, it would turned into red." two children said:"it is shy." N1 asked: "then can he change into other colors?" And tutor said:"yes, so we need to train it how to change into other colors." Children:"how?"

Tutor:"well, our Italian tutor Lupetti will show you and use the yellow group as an example. So we are going to train the robots to turn into Yellow."

Lupetti:"ok, so we change modality" and children were surprised by the fast changed colors and yield:"wow!". Chinese tutor explained to them:"so firstly, we need to set it into yellow color." One child:"how to set it?" Tutor:"there is a button on the middle part of the robots, so you need to turn that button. Now you need to focus on how to train the robots since later each member of the group need to set colors and complete the game by yourselves. Ok let's see, you can turn the button in the middle to change different colos." One child:"What? I can not see it!".Tutor: explained everything again and Children were yielding the color names following the Shyboo.

Then a girl asked:"what about that grey button?" Tutor explained that:"Well, after you decide the color, you need to keep the button pressed and perform your own instruments, until the sound is recorded correctly. Ok, let's try with yellow group, please make a sound and other group needed to be quiet.?" So one member from yellow group started beat his snare drum, and firstly the sound was too small, so Lupetti make a gesture that want him to beat stronger, however at the same time, the rest   Children yielded and Chinese tutor told the boy playing drums:"please beat stronger." And children were surprised by the process that Shybo change colors and record the sound, so they said:"It is so amazing." One child said:"why it does not change into red again?". After recording snare drums, they were trying to record the second sound from yellow group. And when that boy was playing the drum, no answer from Shybo, so N1 beat the table strongly, and Shybo directly turned into red. So Chinese tutor asked: look, it is   scared, who beat the table before?

Other children:point to that girl. And Lupetti said, let's try again. Other children seem like wait for too long, so they said" hurry up, " and they beat the table a lot.

Tutor asked still the boy from yellow group to try again, and when the boy is beating the snare drum, others were playing their own instruments and one child said :"why not let him try?(sorry but I have no idea who the him refers to.)"

Tutor:"shiiiiiii(quiet)".

When the boy is testing the robots, he still got no answer from Shybo firstly, and Children played their instruments, and the camera girl said again:"it is too slow!" Hearing this, the boy beat the drum a little bit stronger, and Shybo turned into red.

Tutor :"ok, let me try this time, maybe the reason we failed is because the boy(N5) could not play a stronger sound."

During the testing of tutor, one child said:"I saw there is a red light in the middle was shining.(I have no idea what she is talking about.)".

And since Shybo turned into red during the testing, which should have been in yellow, all children watched these and started to played their instruments or beat the table, and yield loudly.

Then Lupetti found the problem, and said:"it has been closed, sorry."

And Chinese tutor explained to children that:"before, Shybo was sleeping, so we could try again."

N1:"why it was sleeping?"

Tutor:"because it has different,,,,(did not finish and turned to the girl with bass drum) could you please come here so that we can try with your instrument? "

Tutor:"ok, so now we try again to train Shybo turn into yellow."

Camera girl said:"do you need a stick"(asking the girl with drum).

Tutor asked the girl N11 with drum again:"do you need a stick?" and the girl nod her head. And the rest of the children started another conversation relating to the stick:"but here are sticks, there are chopsticks, "

Tutor found sticks and came back said:"ok, when Lupetti press the button, you need to start perform your drum and others keep quiet otherwise Shybo would be angry.."

Lupetti stopped the gir lN11 when she was performing and said :"too strong, it is too strong." and Tutor explained to the girl. After the training, they test the robots, and children noticed that Shybo changed colors, so they said :"it changed another color. But it is orange." Tutor said :"Let's try again and ."and asked the drum girl perform again, but still Shybo changed into orange, so Children asking:"why it changed into orange?"

After talking with Lupetti

Tutor:"well, maybe Shybo is not ready to recognize yellow color, so we can try another color, blue. Where is team blue, come here."   conscious

Other children they want to try their group color and said:"try purple, try orange.why blue first?"

Tutor asked rest children to keep silence :"shiii."

One member of team blue were playing the organ.

One children saw Shybo changed into blue and said:"waa, blue."

Lupetti explained to tutor why Shybo changed into blue even there is no sound from the Organ. And tutor explained to children:"do you know why Shybo turned blue? Because when Shybo is learning, it also recorded your talking voice, and now you are talking and it could hear you, and it changed into blue. So now we try another color . Ok purple. But this time you need to keep silent, not talking."

After training Shybo to change into purple, they tried to test it, and it works. One child said:"wow, it changed into purple from blue." And tutor pointed at the team blue and said:"you played now and let's see." And Lupetti said:"what was the blue? Is it this one?" Children asked the tutor:"what does she mean?" Tutor asked the purple team to perform again since now Shybo heard children's voice and changed into blue. The boy from Purple team performed again with two sticks and it changed into purple again.

Tutor asked the girl with bass drum from yellow group to try and Lupetti said:"it is better to perform without sticks but only hands. " Tutor explained to the girl.

After training, the girl from yellow group and boy from blue group performed together and Shybo changed into yellow. Children said:"wow, it is amazing." Tutor said:"ok, Lupetti has taught you how to train Shybo, do you understand?" Children:"yes." Tutor:"good, so now each group can perform by yourselves and train Shybo with your soud, ok?" Children:"ok." One children:"which group is the first one?" Tutor ased :"which group wanted to try first?", and all children put their hands up and tutor directly picked the child beside her. And said:"then, you first. And all you three come to this side." Seeing the blue card on the table, tutor picked it up and asked:"which group have the blue card? And take it."

Children were talking:"when our parents will come?"

Tutor said:"we need to keep silence so that green group can finish successfully, ok?"

Children:"ok." Lupetti said:"so now one of them three need to press the button" And tutor asked them:"so who wants to record the sound and who wants to play the sound?" Number 3 child smiled and repeated tutors question(seems like he did not understand the question):"who records the sound? Who plays the sound?". So the tutor explained again:"so you can negotiate among three of you, who wants to press the button so that Shybo could hear and record the sound?" Number 3:"me." And tutor said:"ok, so

you(N3) record the sound, and the rest of you need to play the instruments one by one."
And Lupetti said something and tutor explained to the children:" you see there is a small tail on Shybo, do not touch here ok?"

Tutor:"so now first, you need to pick green color for Shybo,,,,ok good, then which one of you two wants to perform first?"

Tutor:"well you first ok? And come a little bit closer, when it is recording, you can perform." and tutor turn around to other children:"shiiii"

After the first recording of Number 6, Lupetti said:"two times one instrument"

And tutor said to N6:"you play one more time."

One girl(camera) asked for three times:"why it does not speak?"

And tutor turned answered :" he is learning."   (alive, lively, humanlity, intelligently)

After the second performance of N6, Lupetti said:"we can change." and Tutor asked N2 come to performance and said:"when N3 is recording, you can perform your bells like this."

After first recording, tutor said:"good, and one more time." after this instrument, tutor put the cymbals and asked the N6 and N2," who wants to perform this?" and N3 performed this. And tutor said to N2:"you need to perform it in a lower voice, before the sound is too loud and shybo was scared, right?" after the first performance, Tutor said:"ok, one more time." After the second performance, tutor said:"ok, let's try to test it. You three can perform the three instruments randomly. Well let's make Shybo change into another color first." one child said:"change into white." Another said:"change into blue."   (like and pleasant)   Tutor said:"let's make it change into purple." and tutor told Lupetti:"they want to try and check the color." Lupetti changed the robots into yellow, and tutor asked N8 from purple group:"you first and make it into purple." seeing Shybo changed into purple, tutor said:"it is purple now, right? And now you play N2 and make it green." Seeing Shybo in green, tutor said:"look, it is green now ,right?" and tutor asked each member from green color to test one by one and said to them:"now Shybo could recognize your sound." N2 asked the tutor:"can we try again?" Tutor said :"sure. So N8 you first, ok now it is purple, then N2, you play, you see it is green now, then N3,N6. you see it changed into green. And green is your team color." and N2 asked again:"why it can not imitate the sound?" Tutor explained:"well he can not imitate but its special function is that he can recognize the color of the voice." And another girl (camera) asked:"why it can not speak? " one child answered her:"no it can not speak." Lupetti asked the tutor what were the children saying, and tutor explained. Then tutor said:"so now the second group can perform your instruments and train Shybo,

and after all the groups recorded their sound, we can play a game with Shybo. And what was the next group?" Three girls put their hands up and jumped and said:"it is our turn." and the boy stand beside them pointed two of them and said:"it is their turn." Because the three girl belong different two groups. And tutor said:"ok, come here , let's make blue team try." Then the tutor asked N7 with organ:"have you already record the sound of organ?" N2 heard and said:"yes, he has done." and N7 nods her head. Then the tutor said:"ok then you try to perform organ again and let's see if Shybo can change into blue." And tutor said to Lupetti:"they want to check the color since they already recorded." After checking the tutor said:"ok, it works." and Lupetti told tutor that N7 child can record, and the other one N9 can perform the instruments. And tutor said to N7:"so now you help N9 to record the sound and we record this sound relating to blue color, ok?" N2 asked:"doesn't she blow the harmonica?" tutor answered:"she has already recorded it." and tutor said to N7:"first you need to choose blue color."Then N9 performed clarinet. Then Lupetti said:"I think we can make the noise." Tutor said to children:"ok, so you can make noise and let's see if Shybo learned how to change into blue." After hearing the noise, Shybo changed color, and tutor said to N9:"one more time." hearing the sound of clarinet, Shybo changed into blue again, and tutor said:"you see, it heard your sound. And N7 you can try with your instrument." N7 tried with harmonica and tutor said:"ok, and now N2, could you try with your bells?" Then Shybo changed into green and tutor said:"you see, it changed into green, and try with yours, purple group" then Shybo changed into purple and tutor said:"right, it changed into purple. Ok who is the next group?"N2 said:"orange group. They have never tried." Tutor said:"ok, orange group, come here." The girl N10 standing beside the tutor was upset and asked the tutor in low voice:"when is our turn?" Tutor told her:"later will be your turn, ok?"Then tutor asked two girls from orange group:"who wants to record the sound and who wants to perform the sound?" And N1 asked the tutor pointing the button:"what is that for?" Tutor explained her something but i could not hear clearly. Then tutor asked them again:"what is your team color?", N1 said:"orange." Tutor taught how to turn the button to chose color, by saying:"turn left, again, again." N2 said:"no, it is yellow now." Tutor said again:"turn left again."And now it was orange.

During this time, other children were talking, N8 asked N10:"what was the smell of my hand?" and N8 reached his hand near the nose of N10, after smelling, N10 also reached her hand to N8 and said :"you smell."N5 said to N10?:"my hands become the smell of banana, you smell." N10 smelled twice and said :"no, it does not smell like a banana." Then N5 asked N10:"I would like to play your toys." and again during playing N10's

toy, N5 said again :"your instrument has the largest sound among us." Hearing that, N3 with cymbals said :"mine has larger sound than yours." and hearing N3's words, N5 with snare drum stand up and said :"let me try mine" and then he said :"no, N3's has larger sound than mine."

Then tutor said to all children:"shiii, now we need to keep silence so that N1 and N4 could record their voice, right?" and N8 answered :"yes." Then tutor said again :"ok, let's try." after N1 performed the first time, the tutor said :"ok, record again." Then N1 performed also the second instruments two times and tutor said :"ok. Let's try to check." after checking, tutor said :"ok,, good ,now shybo has already record your sound with orange color. And the next group?" Number 5, N10 and N11 put up their hands and tutor said to them :"ok, you three come here."

Then tutor asked them :"what is your team color?" N10 and N11 answered :"yellow." Tutor asked Lupetti :"I think one of them has already done?" Lupetti said :"yes, she(pointing N11) has already done, so she can keep the button." Tutor said to N11:"well, since you have already recorded your sound, so you can keep the button and help them to record, ok? And come to this side, hold the robots, and you two(N5 and N10) can perform the instruments." After their recording, tutor asked Lupetti:"I think we can start." and Lupetti said:"we can start? No, i think they are still missing(N8 and N12". Tutor said to N8 and N12:"ok, come here you two, and what is your color?" N10 thought the tutor was asking her team and answered:"yellow." and tutor smiled and said to N10:"I was asking them(N8 and N12)". Lupetti said to tutor:"I think next time we can try all the colors." Tutor said to children:"ok, so once N12 finishes her recording, we can start to play." N8 looked down to check his number, and then walk to the robots and hold it. Tutor asked N12 and N8:"what is your team color?" N8 answered:"blue" and N12 said to tutor in a low voice:"but i have not recorded yet." and tutor explained to her:"yes, now it is your turn to record the sound and we were regulating the robot." However during this time, N10 and N5 were playing with the camera. And tutor said to N12:"one, two, three, go. "after first recording, tutor said again:"ok, one more time." and this time the tutor helped N12 to play the instruments with louder sound since N12 had little strength.

After all the recording, tutor said to all the children:"so now we need to test Shybo how he learned, ok?" and children said:"ok." and N7 said:"i want to be the first one." and tutor said to all children :"you need to test it one by one, and who wants to be the first?" a lot children put their hands up and tutor asked again :"well, let's perform by orders,

where is N1? N1 come here." Notice that shybo was in color red, the tutor asked children :"who beat the table too strong before? You see shybo got scared, right?"

Then tutor asked children test the Shybo one by one and said:"ok, others keep quiet and N1 can shake your maracas."

Tutor:"ok, then Number 2?" looking at N6 and N6:"no I am number 6." and N2 was performing at this time and tutor asked :"it it the right color?" one child answered:"yes."

Tutor said:"ok. Number 3". "then number 4." and N5 was exciting since he is the next one and he talked to himself:"it would be me next." After N4's test, the tutor moved N1 and N4 carefully to the other side and saying:"be careful, be careful." Then tutor:"who is N5?" N5 came and tutor said to him:"play it a little bit strongly" then tutor asked:"is this color correct?" one child answered:"yes."Tutor asked :" who is N6?" N6 answered:"me."and performed his metal sticks, again tutor asked :"is it correct?" One answered "yes."

Then tutor asked:"N7?" and asked again:"is it correct?" and one child answered:"yes."

Tutor:"N8?"and asked again:"is it correct?" and many children answered:"yes."

They repeated these same question and until N12 finished the test.

After testing, tutor said:"ok, good...well why shybo is not happy right now?"

N5 answered :"because they always make too much noise."

Tutor said :"yes, so did you realize if you make too much noise, shybo would be unhappy and automatically enter into..."

N11:"cap."

N5:"yes, it will enter into its cap."

While during these time, N7 was addicted to playing his harmonica, N8 was focusing on playing with Shybo by performing his plastic sticks. And N1 took N9's clarinet and played it. N9 took her clarinet back and played it herself. N1 repeated three times:"I wanted to have a look of that camera."pointing at the camera.

Color theory introduction

Then tutor asked all the children to come near her and children said:"ahhh, poker card, but we do not know how to play the card.and when shall we start the game?" and N3 said:"tutor, tutor, i found this." Tutor take it over and had a look and ask to children:"this is number 2, where is he?" One child said:"number 2, i don't know". while the other one said:"I know who is number 2." at the same time, N2 has already put his hands up and tutor gave the number card to him.

Then tutor said:"so before, Lupetti has taught you how to train Shybo hear the sound and connected the sound to a color, right? So now we are going to play a game with shybo according to his function." N1 said:"we have no idea how to play." Tutor said:"so how to play this game? " Lupetti told the tutor that children can put the toys on the table and tutor explained to children:"so now you put your toys on that table."and N1 asked:"where do i put the color card?" Tutor said:"give the color cards to Lupetti." so they hand over their color cards and Lupetti said thanks to them.

Then tutor said to children:"ok, ok, come here." And children started to ask:"do we dram a lottery right now?"and most of them repeated:"i want raffle, i want raffle." Hearing children's voice, Shybo got scared ,turned into red and kept shaking.

Then tutor took out a colorful card and children were saying:"wow, tangram." And tutor asked:"is this a tagram?" and one child said:"no." tutor said:"right, then what is this?" One child answered:"they are colors." and tutor said:"yes, it is a multi-color card." and children repeated tutor's words:"a multi-color card." and tutor said:"so today,i will teach you how to use this color-card. So the three colors in the central are called three-primary colors, which means that all the rest colors are made of these three or two of these three colors. So what are the three-primary colors?" Children answered together:"red, yellow, blue." and Shybo shaked again, N3 said:"Shybo is angry." And tutor asked:"yes, but why?" N5 said:"i have no idea." N3 said:"because we answered too loudly." N5 said again to tutor:"they should be our primary colors." and N3 said:"yes, we learned from tutor HuaHua that red, yellow, blue are primary colors." tutor said :"yes, and we call these colors are three-primary colors." and tutor asked again:"then what are these three colors in the outer circle?" Children answered:"they are called secondary colors." And tutor said:"right, so what is the composition of green color?" Children answered:"yellow and blue." Tutor asked again:"then what about orange?" children:"red and yellow." Tutor said:"good job, the what about purple?" Children said:"blue and red." Then tutor said:"so now you learned these colors, how do you call the three colors in the outer circle and how do you call the three colors in the central circle?" Children answered:"three-secondary colors and three primary colors." and tutor said:"ok, so now I will deep your knowledge a little bit, so you see, all the colors is the composition of colors from three-primary colors, for example, green is made of yellow and green."Children immediately heard the error and said:"yellow and blue." and tutor said:"that is right, yellow and blue. So red is the complementary color of green." and children asked:"what does it mean complementary color?" Tutor explained again:"because green is made of yellow and blue, so there is no red

composition of green color, so red is the complementary color of green. And what is the complementary color of orange?" children answered immediately:"red and yellow."Tutor said:"no, not the composition colors, i am asking the complementary colors of orange." and children answered again:"blue." and tutor asked again:"what are the complementary colors of purple?" children answered:"yellow."

Then tutor took out the question card, and child started to read the question:"all the six colors." and tutor asked them:"so what is the question written on the card?" Children answered:"all the six colors." tutor said:"ok, and what is this question?" Children read together:"three- primary colors" Tutor asked:"which colors are three-primary color?" Children:"red, yellow, blue." Tutor put up another question card, and children read:"what is the complementary color of this color?" Tutor asked:"the answer is ?" Children:"orange." Tutor put up another question card, and children read the question and answered:"which color is composed by these two colors? Purple." again next question, children:"which two colors composed this color? Red and yellow." Tutor said:"good, now I am going to question you. What are these colors?" Children answered:"yellow, purple, red." Tutor asked again:"and this color?" Children:"purple." Tutor:"how many purple?" Children:"two." Tutor:"and these colors?" Children:"blue and green." Tutor:"how many colors?" Children:"two." N3 said :"tutor, it is always red." Tutor asked:"why it is always red?" children:"because our voice is too loud."Tutor asked:"then what should you do?" Children:"in low voice." Tutor picked another card and asked:"then what is this color?" Children:"yellow" Children answered again in loud voice so shybo changed into red and shook a lot. N10 child said:"you forget again!" Then tutor picked the chess board, and children yield loudly:"wow, let's play."

Game rules introduction

Tutor put the chess board on the table, children come around the table and yield:"wow." N1 counted the steps:"1,2,3,4,5,6,7,8,,9,10,11,12,13,14,15,16,17,18,19,20" and N7 said:"I can not see it."and he moved to the other side. And N10 said:"I am here."tutor asked:"so how many steps on this chess board?" Children:"20 steps." Tutor:"which is the start and which is the last?"N1,N3,N5,N6,N8,N12 Children:"from here to there, from 1 to 20." Again tutor asked:"can you point the route for me?" Meanwhile, Lupetti put 4 chess on the board, and 4 children picked(N5,N6,N8,N9), N1 did not get the chess and said:"ahhh, i don't have." and tutor said to those 5 children:"ok, give me the chess first." Those five children give the chess out with unwillingness, and N10 said:"don't

worry." and Tutor said:"right, N10 knows not to worry and sooner or later, these chess are yours." and Lupetti said to tutor to rotate the board, and tutor said to children:"let's rotate the board in this way." N10 said:"let's start." N7 said again:"I can see nothing." N1 saw a small picture on the corner of the board and said:"is this?" N5 saw and yield:"Shybo." and tutor said:"yes it is Shybo, but who can show me the path on the board?" N7 put up his hands and N1,N3,N10, N9 started to point on the board and said:"here, here, here, here,,," Tutor said:"you are very clever. And then i will tell you this game is a teamwork game." N1 said:"aiii, another game?"N2 asked:"is that Band-aids?" Hearing it is a teamwork game, N5 jumped to tutor and repeated:"a teamwork game." N2 said:"I want the green chess." N10 said:"I want blue."N1 said:"i want this color." N3 said:"I want green." tutor said:"ok all the children stand in line from N1 to N12." N3 said:"I am Number3." N11 said:"I am 11". Then tutor called the number and let children stand in line:"1,2,3,...11".then tutor asked:"so how many children in total?" Children answered:"12". Tutor then asked:"how many chess we have?" Children:"4". Tutor:" we have 12 children and only 4 chess, what can we do so that each child could play the chess?" Children:"we can be separated in to small groups." tutor:"right, so we need to divided you into 4 small groups, then how many children are there in one group?"some children:"1", some:"2", and some :"3", tutor said:"so each group should have 3 children. And please stand in line and listen to me. So now we are going to divided you in groups. And N1,N2,N3, you three form a group. And I will give you a chess randomly." N3 said:"I want green." Tutor said:"I will randomly give you one color, and you can not choose by yourself, so,,,this one, ok?" They accept and tutor said:"N4,N5,N6 you are a group." N7 put up his hands and said:"me?"tutor said to him:"N4,N5,N6 they three are in the same group, you are the next. And N4,N5,N6, i give you a red chess,ok?" they accepted. Then tutor said:"ok, N7,N8,N9 form a group, and I give you one chess." and N5 repeated the tutor's words:"N7,N8,N9 is a group." and said before tutor:"N10,N11,N12,". And tutor said:"N10,N11,N12 is a group. And i give you one chess. Ok now does every one know who are your group mates?" N5 said:"tutor, they two were quarreling." and tutor said to them:"why quarreling?" they did not say anything, and tutor said to all children:"ok, we know each group is composed by three children and these three children has different work to do. This game is a teamwork game, and the group that finishes all paths first would be the champion, and the champion group would get a gift." Hearing the gift, children are so happy, they jumped and yield:"yeah,what is the gift?" and tutor said:"it is a secret. Do you want to participate?" Children:"yes."Tutor said:"so in each group the first child take

responsibility to read the question, and the first member of each group please put up your hands." Children put up their hands, and tutor said to them:"so the first member of each group need to read the question and tell the next member which colors Shybo should change into. For example, if you pick this card, then which colors should Shybo change into?" Children:"green." Tutor asked:"which instruments had sound that make Shybo change into green?" N2:"small bells, metal sticks,and " Tutor asked:"who belong the green group before? Put up your hands." N2,N3,N6 put up their hands and N2 said:"also cymbals." Tutor said:"right, so if you pick card with green color, you need to pick small bells, metal sticks, and cymbals and perform them to make Shybo change into green. OK, so you can see the color requested from the card, and look at this card, there are three colors." N7 said:"three colors mean that we need to move three steps." Tutor said to N7:"right, you are very clever." Then tutor said again:"and we also have some card with complicated questions, for example this card, it is written what are the composition colors of this color?" Children:"red and yellow." Tutor said:"right, so how many colors in the answer?" Children:"2" and Tutor said:"yes, so 2 colors means we need to move forward for 2 steps." N1 asked:"from where we need to move 2 steps?" Tutor:"from the first steps to the 20th steps." N1:"where are the 20th steps?" N3 and tutor said simultaneously:"on the table." then tutor said:"ok, each group has one minute, and you see Lupetti holds one sand clock, and it counts one minute for each time." N7 said:"give me the sand clock, give me." Tutor said :"Lupetti will hold it for us and count the time for us. And first number of each group will pick the card and tell your group mate which color you need to move(here i think the tutor made a mistake, i think she wanted to say which color to chose instead of move) and how many steps you need to move." N1 asked:"do we play one group after the other?" Tutor said:"yes, and the second member of the team need to pick the instruments from that table and perform it around this table so that Shybo could hearing the sound and change colors. And who are the second member of each group? Put your hands up." N5:" I am the second" and yield to others(N8 to N12 standing in the end of the lines):"the second put up your hands." Tutor come close to N8-N12, and asked them:"so, let me ask you, what is the task for the second member of each group?" N10 said:"we don't know" and N7 said:"I know, I know." and tutor repeated the tasks again for them:"so the second member need to move between these two tables and pick the instrument to make Shybo change colors." N10 asked again:"then who play the chess? The third one?" Tutor:"yes, the third one need to move the chess. So every group, you need to give the chess to your third member." N2 and N5 asked:"then who take the multi-color card?" Tutor said:"the first

member." then tutor asked children again:"so what is the task for first member?" children answered:"pick the question card and read." Tutor:"ok, and also tell his group-mate the number of steps to move, and the second one?" Children:"pick the instrument and perform it." Tutor said:"the the third one?" Children said:"holding Shybo's baby(they call the chess Shybo's baby). " Tutor asked:"why they hold Shybo's baby? They need to move it, right?" Children:"yes, move it." Seeing the last few children, N10,N11,N12 did not focus on the rules, tutor walked near them and said:"so every one is clear about how to play? Then I will ask you the rules. What is the task of the second member?" Hearing tutor is going to ask them question, N10,11,12 turn around and started to think. N8 answered:"the second member need to walk between the two table and take the instrument and perform it." Tutor said:"good, and the third member?" N11 or N12 said:"move ." and tutor said:"ok, each group has only one minute in each round. And where is first group?" N1,2,3 put their hands up. Tutor said:"And where is second group?" N4,5,6 put their hands up. Tutor said:"And where is third group?" N7,8,9 put their hands up. Tutor said:"And where is fourth group?" N10,11l12 put their hands up.

Playing Boardgame

Lupetti said:"maybe we can start."Tutor asked children to come around the table, Lupetti asked:"who is the first group?" Tutor said:"so, the first group, we are going to start." N3 said:"aya, i forgot, who is the first?" other children said:"the first group started first." Tutor said:"ok, now let's put all Shybo's baby on the table.   (organism) And which color is yours , the first group?" First group said:"blue." And tutor asked:"when one group is playing, what should the rest group do?" Children said:"be quiet." Tutor sai:"be quiet, because if you scare Shybo, he would be upset. And there is a small trap in this game." children asked:"what trap?" Tutor:"the trap is , which group made Shybo change into red, then this group is failed in this around." N10 said:"so it is the next group to play?" Tutor:"yes, it is next group's turn." N2 said:"so we can not make any noise."N4 asked:"do they move backward one step?" Tuto said:"no. They do not need to move backward, but they could not play in this around. They just suspend for a moment." N1 said:"so they can not move." N5said:"they are out. " and tutor said:"yes, in this around, they are out." and tutor explained to Lupetti.
Then tutor asked:"where is the first group? The first group come here and the rest go there. And the second group need to prepare for yourselves." N5 said to N6:"don't be in my way." Tutor asked the first group:"who is the first member?you? Ok where is

your multi-color card?" N1 take out her card and tutor said:"ok, you read the question card and check the multi-color card." N1 asked:"why check the multi-color card?" Tutor said:"because there are some complicated questions you can use the card to find the answer. But if you can remember the card, you do not need to check it." N1 said:"I remembered."Tutor said:"good, ok then what is the task for the second group?" N2:"pick the instrument." Tutor:"ok, then the third member?" Children:"move the chess."

Tutor said:"ok, so let's keep quiet, and they can start."

N1:"purple, blue" N2 pick the harmonica and the plastic allegro and performed them. Lupetti helped them to move the chess, and tutor explained:"the start position is the first step. And then go on, if you can move more steps in one minute, it is better."

N1:"orange, green"

N3:"no, orange, blue, red"

N1 turn around and speak again to N2 loudly:"orange, blue and red".

N2 told her:"xuuuu(means in low voice)" and trying to memorize which instruments he should take.

Tutor and other children were repeating in low voice:"time is nearly up. "

N2 scratched his head and trying to memorize, but still he could not memorize the blue color is harmonica, and they failed this time.

Tutor asked:"ok, so let's review each instrument and colors. The Bass drum, which color is it?"

N10 Said loudly:"yellow", others some said red, some said yellow.

  Tutor:"and this?"

Children:"yellow."

Tutor:"and this?"

Children:"purple, then green, also green,purple, orange,orange, green,yellow,green."

After review, N1 asked to the tutor again:"what is the multi-color for?"

Tutor explained:"if you read some completed questions about composition of colors, you can use this card to find the answers." and N1 give the multi-color card back to tutor, and tutor:"i can give this to you." Other children:"ahhh?" and N12 pointed at the chess and asked:"can you give this to me?" seeing the reaction of children ,tutor said :"no, this I can not give it to you." and said to N1 :"well, then you take it for me for a moment, later give it back ok?"

Then tutor said:"the second group, let's start."

N4:"purple."

N5 picked the plastic sticks and performed it.

N4:"purple, yellow, orange."

N6 moved three steps, and Lupetti moved two steps back, so tutor said to Lupetti:"they have three colors." and Lupetti explained:"each card for one step." Then tutor explained to the children:"ok, now you can move only one step for each question card."

N4: "red".

N2 asked:"which instrument is for red colors?"

N5:" I have no idea."

N3 pick the bass drum and give it to N5, seeing this, N10 shouted:"no no, it is yellow, it is yellow."

Tutor said:" xuuu, red, how could Shybo change into red?"

One child shouted (maybe it is N12):" red."

And others realized they need to scare Shybo to make it red.

And tutor said:"one more time, you need two red colors."

Children yielded loudly again:"red".

Then tutor said:"ok, time is up, the next group. Which group is the next one?"

N1 said:"the third group."

Tutor said:"ok, where is the third group? All the groups that have played move to the other side, and the third group come here."

N1 said:"I want to stand here."

Tutor said:"you move there and later when it is your turn you can come here again. Where is the third group? "

N7,8,9 put up their hands, and tutor said:"start."

N7:" yellow, blue, red."

N8 picked the snare drum for yellow color, and trying to find other instruments. Some children shouted:"red", and Shybo changed into red, the tutor asked:"and still blue?"

N8 perform the harmonica, and Shybo changed into blue.

Tutor said:"yellow, and time is up, quickly."

Other children yielding:"time is up, time is up." N8 pick plastic sticks, and Shybo changed into purple, and N2 said:"it is purple".Tutor said:"ok, failed."

N10:" the fourth group."

Tutor said:"yes, the fourth group come here, others move their. and ready, start."

N10:"orange, and yellow"

N11 went to pick the instrument and N1 shouted to her group mate:"the first group, here."

N11 picked the correct instrument and performed, N10 moved the chess and said:"red, yellow, orange".

N12 yield loudly:"red." then others yield following her:"red."

N11 performed snare drum and Shybo changed into yellow.

N4 helped them and performed maracas and Shybo changed into orange.

N10 picked another card and read with N12:"blue".

Tutor said:"sorry, time is up."

N5:"yeah,they have the same process of games with us."   (pleasant)

Tutor said:"the first group come here. start"

N1:"red, purple, yellow"

N3 yield loudly:"red."

N1 take the snare drum on the table and beat it strongly. Tutor asked her:"what is this color?" N1 pointed the yellow on her question card and said:"yellow." N5 picked harmonica and performed it. Tutor told him:"a little bit louder." seeing Shybo changed into blue, tutor asked other children:"is this blue?" and N12 said:"yeah, purple is another." N2 bring the bass drum and N1 directly performed it without thinking, and it is still wrong and N9 said:"this is yellow." N5 said:"time is up, next group." N2 finally picked the right one, the plastic allegro and performed it loudly, but Shybo has heard too much noise so it changed into red. And tutor said:"this round, the first group failed." Then tutor said:"the second group, where are you?" N4 yield to the children around the table with instruments:"you guys come here." and N4 and N6 put up their hands and N5 came too. Then tutor said:"who take this instrument? Please put them back."

One child asked:"who took these?" Another child said:"it is not me."

Tutor explained to the children what Lupetti said:"so now we changed the rules, if you see three colors on the question card, you can move three steps." N4,5,6 heard carefully and yield:"wow." and N4 asked:"so we don't move only one step?" and N9 asked:"so if there are two colors, we need to move two steps?" and tutor said:"yes, that is right. Ok let's start."

N4:"yellow, yellow"

N5 picked snare drum and performed it.

N6 moved the chess.

N4:"and another yellow"

N4:"purple, green, orange."

When N5 is picking the toys, Shybo changed into red, and tutor said:"you failed and your loud noise leads to the failure of second group, what should you do? Would you

like that the second group can play one more time?" N1 said:"yes." and tutor said:"ok, so you can finish this card. Ok look at your card, what are the colors? Purple, green, and orange. Ok " N5 repeated:"purple, green, orange." N4 said:"bring orange first" and she went to pick the instrument and performed maracas. N9 said:"time is already up." Tutor said:"ok, you can move one more step forward, and who is the next group?"N1 said:"it is fourth group."Tutor asked:"who are the fourth group?" N5 said:"isn't it should be the third group?" Tutor said:"yeah, the third group, who are you?" N7,8,9 came and tutor said:"start".

N7:"yellow,green."

N8 performed snare drum and metal sticks

Tutor remind N9:"the first move and the second move."

N7 pick the second question card and directly put it down without reading it, tutor pick the card and ask N7:"what is written on this card? Three-primary colors."

N7 said:"three-primary colors."

Tutor asked:"what colors are three colors?"

N1 answered:"green yellow red".(she made a mistake, but no body notice that.)

And other children followed her:"green yellow red."

N9 shouted at Shybo:"red"

Then another child shouted:"green." (I didn't see who is speaking.)

N8 performed snare drum and Shybo changed into yellow.

Tutor said to N9:"don't forget to move the chess."

N9 moved two steps again. And Tutor asked:"did you perform all the three colors?" One child answered:"no." Tutor said:"you just finished one color, right?" and moved their chess back ward two steps. N9 shouted:"hurry up, time is nearly up!"then said:"time is up now." and tutor said:"ok, then next group."

N1 said:"the fourth group."

Tutor asked:"who are the fourth group?"

N10 said:"we three."

Tutor said:"ok, ready. What is your chess color?"

N10 said:"green"

Tutor:"ok, ready, where three belong green group?"

N11 and N12 were standing beside the instrument table and they put their hands up.

Tutor saw them and said:"start."

N10:"red, blue, green."

N12 shouted:"red"

N10 said:"red blue, green, also blue and green"

N12 performed harmonica, and N6 helped them and performed metal sticks.

Tutor said to N10:"you need to move forward three steps."

N10 picked the second card and read it:"red, yellow."

And N12 shouted:"red."

Tutor said:"what it the question written on the card? Read it carefully."

N10:"which color is composed by the following two colors?"

Tutor:"so which color?"

N10:"orange."

N11 picked the maracas and performed it. Shybo was green so N5 said:"this is green."N1 said:"orange, this is orange." Shybo changed into orange at the same time. But N4 said:"no, shybo is yellow." so N5 performed again the maracas, and Shybo changed into purple, N5 yielded loudly:"purple?" and Shybo changed into red. N5 shouted:"ahiii."

Tutor said:"then next group."

N5 said:"the first group."

N1 said to her group mate:"come here hurry up."

Then N1 said to tutor:"can we start?"

N2 said to N1:"you pick a card first."

N1 said to N2:"not started yet."

Tutor said:"ok, next group, start."

N1 pick the card and read:"blue, green, orange."

N2 pick the cymbals and performed it, but shybo did not change into green. N6helped and performed the harmonica, and shybo changed into blue, N5 shaked the maracas and shybo changed into orange. N5 said:"green, also green."N1 said to N2:"green" and N2 picked metal sticks this time and performed it, Shybo firstly changed into red and then into green. N5 said:"ok, green is done."   Animacy

N3 moved the chess forward for three steps.

N1 picked the second card and read it :"purple and yellow."

N2 took the bass drum and performed it, tutor asked:"what is this color?"

N10 said:"yellow."

Tutor said:"and purple?"

N2 performed plastic allegro.

Tutor said:"good"

N3 moved the chess.

N1 read the third card:"green, orange"

N10:"green orange."

N12:"time is nearly up"

Tutor:"ok, time is up. Next group, who is the next group?"

N4 said:"me and them."

N1 said to her group mate:"come here, the first group, give them some space."

Tutor said:"ok, ready start."

N4:"red, yellow"

N6 shouted:"red."

And other shouted following him:"red."

Other children said:"hurry up, hurry up."

N5 performed the snare drum and N6 moved the chess.

N4:"orange."

N5 performed the maracas.N6 moved the chess.

N4:"orange, orange" and N4 pick the maracas near her and performed it.

N10 shouted:"orange."

Tutor said:"ok,ok"

N10:"two orange"

N4:"red, blue"

N5shouted:"red"

Tutor said:"then blue."

N2 helped them and performed the harmonica.

N7:"ok, hurry up, time is nearly up."

N4:"green"

N5 performed metal sticks and tutor said:"ok, time is up."

N4,5,6 jumped happily and yield:"yeahhh."

N2 said to them:"I have helped you."

N5 said to N2:"thanks, thanks"

Tutor said:"ok, next group, what is the color of your chess?"

N7:"yellow"

Tutor:"ok,yellow, ready ,start."

N7:"green, blue"

N8 performed metal sticks and since there are too much noise, Shybo could not here green, tutor said:"xuuu". Then tutor said:"ok, green is done, blue is done, next"

N7:"red, blue".

N6 shouted:"red"

N7:"green, green"

Some children still saying:"blue"

N9:"no, green."

N3 helped them and performed harmonica, one child said:"this is blue."

Other said:"green ,green" (and here they did make a mistake, since harmonica is blue color, but the required color is green.)

N7 continued:"purple"

Tutor asked:"where is green? Did you performed green?"

N8 was performing the plastic sticks and one child said:"this is purple"

And tutor said:"this is purple."

N9 moved the chess, and N10 said:"ok, ok."

Tutor said:"ok, time is nearly up."

N7:"blue, red"

N6 shouted and others followed him:"red"

N3 said:"time is up."

Tutor:"OK,time is up. And next group."

N1:"the first group has lighter work."

Tutor:"ok, next group, ready, start."

N10 loudly:"yellow"

Shybo changed into red and N4 said:"ah, look at shybo."

Tutor said:"ok in a low voice and be careful."

N10:"red, orange"

All children:"red"

Tutor said:"then orange."

N5 helped and performed, N4 helped and performed too.

Tutor said:"wait wait, wait for shybo."

Then shybo changed into orange, and N10:"red".

N2 shouted first and others followed him:"red".

Tutor:"you did not move the chess,who is responsible for that?"

N10 moved the chess for two steps and N2 said:"three steps, one step more", Lupetti moved the last step for them.

N10:"red"

All children:"red". N1 helped them to move the chess.

N7:"they catch us now."

N10:"blue orange"

N4 repeated:" blue, orange"

N12 performed the maracas, and N5 helped them and performed the harmonica.

Shybo turned into purple, and N7 said:"this is purple." later shybo turned into orange.

N1 helped them move the chess.

N10:"blue orange"

Tutor asked:"then blue."

N5 performed again the harmonica, Shybo changed into red and N2 said:"they failed."

Tutor said:"wait and perform again.ok blue"

N10:"purple, purple."

Lupetti said:"I think they finished the time."

Tutor said:"oh,time is up."

N10:"the first group."

N4,5,6 were jumping and laughing.

Tutor:"ok, ready, start."

N1:"green"

N12 repeated:"green green"

N6 helped and performed metal sticks.N3 moved the chess.

N5 said:"they have helped us, so we should help them too."

N3 said:"yes"

N1:"orange red"

N2 shouted and others shouted too:"red"

N1 said:"purple"

N2 pick the allegro and performed it.

N1N5:"green purple"

One child said:"time is nearly up"

N12:"time is up."

N1:"yellow"

N1:"blue, blue"

Children:"blue, blue"

N7 run to the table and pick the harmonica and N5 said:"hurry up."

Tutor said:"good, blue, move the chess here."

N2:"time is nearly up, time is up."

Tutor:"time is up. Ok, next group."

N12:"the second group."and yield loudly to shybo:"red"

Lupetti remind her to be in low voice.

N5:"we are here, we are here."

Tutor asked N4:"which color is your chess?"

N4:"red"

N4:"blue, blue"

N5:"where, where" and seeing N7 is performing the harmonica, he said:"ahh."

N4:"green"

N5:"green, hurry up, hurry up."

Lupetti and tutor remind them in lower voice.

N4:"green, yellow"

N5:"okok. It is done"

N4:"purple"

N5:"which is purple, which is purple"

N3:"this is purple."

N1:"pk, purple is already done"

N4:"purple, blue"

N5:"purple, blue,purple" N7 performed harmonica.

N1:"blue is done" and moved the chess.

N4:"red"

N4 shouted:"red" N1 helped her move the chess, N5 is jumping.

Tutor:"ok, now only the last step is remained."

N4:"green, orange."

Tutor:"no,no, time is up, ok you only remain the last step."

N4,5,6 yielded:"yeahhh" and jumped.

Tutor said:"you still need to finish the last step. Then the next group, who is the next group, be ready"

N9 said to N8:"come here"

N7:"i am coming,"

N8:"not start yet."

Tutor:"which color is your chess ?"

N8:"yellow"

Tutor :"ok, start."

N12:"start."

N7:"yellow, orange"

N10 performed bass drum, N12 and N6 performed maracas.

N7:"orange"

N9 was going to move the chess and tutor asked:"orange, which is orange? Don't wait, make the sound of orange"

N8 performed the maracas again.

N7:"blue" and N7 performed the harmonica in his hand.

N1:"next next."

N2:"next, hurry up."

N7:"red, yellow"

Children:"red" and N10 was performing the bass drum.

Tutor said:"ok, wait, you perform again."

N10:"ok, done, next, next."

N7:"orange"

N10:"time is nearly up."

Tutor:"time is nearly up."

N5:"orange."

N10 performed the maracas.

Tutor:"ok,. next."

N1 pick the card and give it to N7 and said:"it is your turn."

N7:"yellow."

Others :"time is up."

Tutor:"time is up, ok, next group"

N1:"the fourth group."

N3:"the fourth group."

N1:"the first group is here."

N7:"we almost catch them."

N4:"definitely we are going to win, we just remain the last step."

Tutor:"ready, strart"

N10:"orange"

N12 performed the maracas, and N11 performed the snare drum,N12 said to N11:"yours is yellow, it requested orange." N5 said to N11 again:"orange, orange."

N2:"is it wrong? Which color?"

N10:"yellow, red"

N5 saw they did not move the chess and asked :"which color is your chess?"

Tutor asked N10 too:"which color?"

N10 moved the chess.

N12 shouted:"red."

And N12 went to pick the snare drum, other children shouted:"red".

N1 said:"move 1 step, move 1 step."

Tutor:"the green chess move 1 step."

N12 performed the drum.

N10:"orange, orange" and N12 picked the maracas.

N1:" shake it strongly."

N1:"move one step."

N1:"shake again."

N10:"yellow blue"

N7 performed harmonica. N1 said:"move one step."

N3 said:"move to here."

N10:"green"

Tutor:"ok, time is up."

N5:"yeah, it is nearly our turn."

Tutor:"who is next group?"

N1:"the first group."

N6:"we are the second group."

N1 N2 said to N6:"now is the first group."

Tutor:"ready, start."

N2and N1 shouted:"red".

N5:"red"

N2:"green, green."

N1 said to N3:"move the chess"

N6 performed metal sticks and N1 said:"move one step"

Reading the card, N1 hesitated and N2 said:"blue, green", and N1 said too:"blue, green".

Again N7 performed the harmonica,then N2 performed the metal sticks, N5 said:"ok, green is done."

N3:"last step, hurry up, hurry up"

N1:"purple"

N2 found the plastic allegro and N5 was upset and said:"ahhhh", and N4 had an upset expression on her face too.

N3:"wait a minute." and N3 moved the last step. And N7 yielded:"yeah."

N3 jumped and yield:"yeah." also N1 yield:"yeah"

N2 realized they are the winner later and also jumped, tutor asked:"who win the game?"

N2 said:"the first group win."

Tutor:"we said before, what the winner group would have?"

N3,N2:"a gift."

Tutor:"ok, we said before only the winner group will have a gift, right?"

N5 low down his head and said in a low voice:"yes."

Tutor:"but I found during the game, all the groups helped each other a lot right?"

N5 raised his head and said in a medium loud voice:"yes."

Tutor:"so the gift should belong to every children, right?"

N5,N6:"yes"

Tutor:"do you want the gift?"

Children:"yes."

Tutor:"ok," children followed the tutor and tutor said:"please stand in line."

N2:"what is the gift?"

Tutor:"ok, stand around the table."

N3 and N6 were standing beside Shybo and yield:"red",then all the children yielded :"red", Shybo shaked a lot and N1 tried to stop its shaking by hand, and Lupetti said:"no,no,no", N1 run away and yield:"red, red"   interact and relax and pleasant

Tutor:"before i give you the gift, do you like Shybo?"

Children:"yes"

Tutor:"do you want to play with him at home?"

Children:"yes"   like, kind, pleasant, nice, friendly

Tutor:"then what did you learn today?"

Children:"colors"

Tutor:"ok, then i will review the knowledge we learned today with you."

Children explained the rules to their parents:

N2:"the second member should pick the instrument, after picking the instrument.."

N7:"colors"

N2:"after picking the instrument, it will change colors."

N5:" changed into.."

N2:" it will changed into different colors, for example, these two colors, red and green."

N7:"red"

N5:"red".

N2:"if it changed into these two colors, we move the chess."

All children:"red."

Tutor:"and here are cards, I put some cards with something written on it, have you played these kind of cards?"

N1:"yes"

Tutor:"what is written on the card?"

Children:"which color is composed by the following two colors?"

N2:"Green".

Tutor:"good, then I taught you how to use this multi-color card, so who knows how to use it?"

N1:"what do you mean?"

Tutor:"you can tell the parents what is the name of these three colors in the center?"

N2 first and others shouted together:"three-primary colors"

Tutor:"why it changed into red?"

Children:"because our voice is too loud."

N9:"so it got scared"

Tutor:"ok, so these three are called three-primary colors, and what about these three?"

N2:"secondary-colors"

All children:"secondary colors"

Tutor:"how is the secondary colors created?"

N2:"they are created.."

N5:"from the those three colors"

N7:"they are the composition of three-primary colors."

Tutor:"what is the composition color of orange?"

Chidren:"red, yellow"

Tutor:"good, then what is the complementary color of orange?"

Children:"blue"   ?????knowledgeable

Tutor:"good, you learned quite well today. Ok now i put a few difficult questions inside all the cards and you can show your parents how to play it."

N1:"it is easy"

Tutor:"wait a minute"

N5:"take it(the sand clock) here"

N1:"start."

N2:"the first group."

Tutor:"which three children are the first group?"

N1:"ahh, we need to play again?"

N5:"I am the second group."

N3:"ok, let's start."

N2 repeated:"where is our first member?"

N3 pointed N1, and N2 said:"ahh, she is here."

Tutor:"ready, start."

N1:"red, yellow"

N1,N3:"red"

N2,N6,N11 performed the drums loudly.

N1:"ok, it is done."

N10:"move two steps."

N3:"red, yellow, oh ,yes."

N1:"orange."

N1:"orange, orange"

N10:"two orange."

N1:"hurry up, another orange." N6 performed the maracas again.

N1:"yellow ,blue"

N5 repeated N1:"yellow, blue"

N7 performed the harmonica

N5:"ok, blue done." and he performed snare drum directly.

N1:"green"

N3:"green, green"

N5:"green, haha,"and performed metal sticks and then said:"ok, done."

N1:"red"

N3 shouted and others followed him:"red"

N1:"red, yellow, orange"

N6 performed snare drum.

N10:"time is nearly up."

N1:"ok, orange. Ahh time is up."

N3:"yellow and orange."

N10:"time is up."

N2:"time is up."

Tutor said:"ok, the second group, be ready. What is the color of your chess?"

N5:"red".

N6:"this time we must work hard."

N4:"orange, orange."

N5 performed maracas

N4:"yellow, purple red."

N4,N7shouted:"red".

N4:"yellow."

N5 performed the snare drum, N10:"beat it a little bit harder." N4:"beat it a little bit harder." seeing it does not work, N5 use the drum to beat the table, children were laughing.

N4:"purple"

N7 performed harmonica and tutor said to him:"harmonica represents blue."

N5 performed plastic allegro and N10 said:"ok, ok, done."

N4:"red"

N4:"green"

N10:"green is done"

N4:"orange."

N1:"orange"

N10:"green ,green" and N3 performed the metal sticks.

N1 said to him:"could you please bit it harder?"

N5 took the sticks from N3 and said:"let me do it."

N4:"orange."

N10:"time is up, time is up."

N4:"orange"

N10:"time is up."

N4 shouted sadly:"ahh"

N2 said:"the third group can start."

N10:"the third group."

During this time ,tutor was explaining to the parents:"we have put some question cards and children pick the card and need to figure out the answers and then move the chess. And they can use this multi-color card to help them thinking."

N7:"blue, red"

All children:"red"

N10:"and blue? No not yet."

N7 performed harmonica in his hands.

N5 said:"blow it harder."

At the same time:

One parent asked the tutor:"if the sound is too loud, it will change into red?"

And tutor explained to parents:"if the sound is too loud, it will get scared and it's cap would low down. And this is to remind children if they make too much noise, they will fail the around."

N10:"ahh"

N5 said to N7:"wait a moment, stop performing,"

N5 performed his small bells and N2 took the harmonica from N7 and performed it ,

N10:"said, time is up." N5 took the harmonica from N2 and said:"let me do it."

N10 shouted:"time is up."

N5:"stop talking."

Tutor:"ok, next around we invite your parents to play together, ok?"

Children:"ok."

Children were yielding and trying to find their parents:"mama,..."

Tutor explained to Lupetti:"they would like to teach their parents how to play it."

Children were talking with their own parents and explained the rules.

Tutor said to one parent:"well, this mother, you read the colors written on the card."

The parentN1 said:"ok, i read the colors, yellow, purple, red."

N1 child yielded:"red".

N10 performed plastic allegro, and her mother took it over and performed and asked her:"what is this color?" N10:"this is purple" and her mother repeated:"ahh, this is purple"

One mother(N2's mother) took the maracas and shook it, N1 and N2 said to her:"nono, this is orange."

N7's father asked N7:"what color is it for the instrument you hold?"

N7:"this is purple."

N2 said to N10's mother:"the one you hold is purple."

Later, Tutor said:"because right now the voice is too loud ,so it is in red color, and that is why we do not have instruments that represented the red color."

N7 repeated:"three-primary colors" parents were asking which instruments stand for which color and they do not clear about the rules.

The first parent said:"purple, green, orange."

Children repeated:"purple green, orange."

N12 yield:"this is orange, time is up."

N5yield:"time is up".

Tutor said:"ok, now listen me, I will choose one child and one parent."

N10 put up her hands and said:"tutor."

Also N2 put up his hands.

Tutor said:"ok, i will randomly pick a number, ok? Number 6."

N6:"me."

Tutor:"ok, number6 and his mother, you need to explain which color each instrument stands for, this is the first step. Then you corporate together and separated the work, one pick the card, one pick the instrument."

N2 asked:"then who play the chess?"

N7:"Number 7 move the chess ?"

Mother of N6 said to N6:"yes, so I read the question and you pick the instrument."

Tutor:"yes, mother read the question and move the chess.ok?"

N6's mother asked:"from where i move the chess?here?"

N5:"from here,then here,then here..."

One mother said to N5:"other children keep silence."

Another father said:"yes, other children list to the tutor, ok?"

N10:"yes, do not start now."

Tutor:"ok, all the children, put your instrument on the table over there."

Tutor and one parent:"other children can stand on the other side and watch."

Tutor:"ok, when N6 and his mother were playing, what should you do?"

N4:"keep quiet."

Tutor:"if you make too much noise, what would happen?"

N4:"we would scare Shybo."

Tutor:"that is right. Ok, let's see how well N6 learned today?"

N6's mother asked:"start now?"

N10:"start." and she upside down the sand clock.

Tutor said:"ready, start."

N6's mother said:"purple, green, orange."

Tutor:"xuuu"

N7 performed metal sticks and his father stopped him.

N6's mother said again:"purple."

N6 brought the metal sticks and said:"this is green."

His mother said:"then you perform green first."

N5 said:"green is already done, now purple." and he performed plastic sticks.

N2 said:"this is orange." and his mother said:"you go there and perform it."

N6's mother repeated the colors and move the chess. Then she picked the second card and read it:"yellow, purple, red."

N5:"yellow, purple, red."

N1 and N4 shouted loudly:"red"

Mother said:"purple"

N2 performed the plastic sticks.

Tutor said:"wait, wait shybo calm down. Ok, now perform again."

N2:"ok, yellow and purple is done. Move move."

N6's mother:"red, yellow".

N10 said:"time is up. Time is up."

N6's mother said:"time is so fast, we almost did not play it."

Tutor said:"then play again."

N10:"once again."

N12:"once again."

N10:"start."

N12:"start."

N5 asked:"what colors?"

One parents said:"other children keep quiet please."

N6's mother said:"green, red."

N7 said:"i have green", saying and performing metal sticks.

N12 shouted:"red."

Tutor:"shouldn't you be quiet then Shybo could change into another color?"

N12:"ok, now it is green."

N6's mother asked:"it behaves like this because of too loud noise?"

Tutor explained:"yes, only when the decibel levels is too high, it would behave like this. And actually if you play it at home, sometimes parents speak loudly to children ,then it will behave like this."

N2:"hurry up and play , time is nearly up."

N12:"hurry up and play, time is nearly up."

N5 shouted:" red."

N6's mother:"blue." N6 performed the harmonica.

N6's mother:"green."

N7 was performing the metal sticks.

N2 and N5 shouted:"green".

N12:"time is nearly up."

N12:"time is up."

N2:"both these two instruments are green."

N4:"let's start again, time is up."

And tutor was explaining to parents:"because there are too much sounds so it can not recognize each sound and it is in red."

N6's mother:"anyway, it change colors according to the sound it hears, right?"

Tutor said:"yes".

N5 and N2:"time is up. We start now."

N6's mother:"ok, i choose one more ok? Purple."

N2 picked the plastic sticks and N5 took them away and said:"let's do it faster."

N6's mother:"yellow", one child performed the drum.

Another parent said:"ok, yellow is done, next."

N6's mother:"orange."

N5 said to N2:"the one you holding is orange." and N2 shaked the maracas.

Tutor said:"actually , we want this small robot can be a bridge between parents and children, sometimes, parents will speak in loud voice with children, and children would get scare, just like this robot."

N5,N2,N6 were still playing the game and read the colors.

Then another tutor said:"ok, now we are finished today. And children now put your toys back, and go to the classroom."

Tutor said to another tutor:"we have prepared a small gift for your teacher's help for today, it is our handmade bookmark"

The second tutor said:"ok, thanks a lot."

--Orange group:

N1(maracas round)+N4(maracas long)

--Yellow group:

N5(snare drum)+N10(empty box)+N11(bass drum)

--Blue group:

N7(harmonica)+N9(clarinet)

--Purple group:

N8(plastic sticks)+N12(plastic allegro)

Green group:

N2(small bells)+N3(cymbals)+N6(metal sticks)

Appendix2: Maps of children's behaviors

Individual behavior:

(N10)

"you need to blow it with your mouth."

Before the video, just see the picture

Seeing shybo changing color in the video

"It has no hands, how could he play with us?"

"So it is a light, colorful."

During training the robots, other children were making noise.

"Don't make it angry again ok?" said to other children

(N1) N10 answered to N1 when others is training robot

"It can not speak". X2

(N3) N10 shouted to N3 when N3 is going to choose the wrong musical instrument.

"No, that one stands for yellow."

Knowledgeable & facilitator

(N10, Lupetti)

Help

(N7)

| Without knowledge of how to play harmonica |
| Behavior: performing Harmonica when tutor is teaching children how to train Shybo |

| Dispersion from unknown musicial instrument |
| Interruption of experiment and dispersion of himself |

(Harmonica)

During his group playing, he Skipped question once(maybe because of difficulty or incomprehension) on card during his group playing.

During playing phase, he took harmonica with him, and perform as long as blue color is requested.

During his group playing, Slowly and sometimes forget to pick cards.

(Video presentation)

"I did not understand."

"I understood."

Quality of the presentation video

(N1)

During watching the

"It can move or not?"
"Why does it not move?"
"Ah, so it can not move."

"Look, there is a camera." **X3**
Got explanation from the tutor at the last time

Risks from unknown

(Camera)

During the presentation of training Shybo. She did not understand why it change color.

What does it mean? **X3**

She did not got any response from tutor. But it is not a big problem, because she understood later

Asking during when other children is training robot., and answered by tutor and N10

"Why it does not speak."

Asking before her group is going to start and the second group is going to start to play.

"what does this color used for?."

Tutor answered her both two

N1 asked her groupmates to leave space for next group after they finished, or to prepare in advance since they were the next group.

"Hi, group one, come here." **X2**

First responder, and help other

Suggesting during the third group is playing

"to make it red, you just shout to it."

(N5) — Watching the video — "It can change color."

(N5) — First interaction with Shybo, and first sacred Shybo — "It's scared." "It's scared so it lows down its mushroom cap." — Child who understand the situation, probably

(N12) — During first group playing — "Time is up!" X2

(N12) — During First group's playing, the only child who memorize correctly the color with respect to one musical — Memorize correctly.

(Tutor)

Said to all children

"Not all robots have legs and can walk, its special function is that it can change colors."

(N1,N2)

"Ok, Scilence."

Problems of suspention of experiment

"Italy, pasta(N1)"
"I want to eat pasta(N2)"

(N1)

"The camera is used to record us."

Answered question from N1. Stopped children's dispersion.

First time playing, and seeing children have difficulty to recall.

"Let's recall which color does each musical sounds stands for."

Solve problems and reduce time consumption.

(N1, N4, N9) — Others were training robot — Watching the photographer taking picture and recording. ‑‑‑ Risks and dispersion

(N10,N2>N4,N8) — **(N10,N2)**Always **follow** and **response** to tutor during color theory introduction. Standing **closest** to Tutor. **(N4,N8) follow** but not

(Tutor)

(N5,N1,N3>N9>N12) —
Standing position **in the middle**.
(N5,N1,N3) mainly focus on tutor than robot, and actively to answer questions.
N9 mainly focus on tutor but not answer so positively.
N12 less focus then candidates before.

. All standing in the **out layer**
 (N11 focus on shybo or just dispersion.)
 (N6) Focus on shybo, always look back..
 (N7) easy dispersion, neither focus on tutor nor robot.

(Shybo or just dispersion)

(N11,N6>N7)

{N10, N12}

During explanation of game rules

Sometimes Dispersion&playing or touhing Shybo but they understand rules

{N1,N2,N3,N5, N6 }

During explanation of game rules

Focus and response actively

Possible reason: tutor's general movement around (N3-N6). Tutor seldom come closely to them and Shybo was just behind them.

During the game:

(N1,N2,N3

Winner, Coop. well and resp. fast.

Helper and facilitatior:(N1,N2,N3, N5,N6>N7)

Watcher: (N4,N8,N9,N11,N12)

Dispersion: N7>N10

(N7,N8,N9)

Respond slowly and sometimes forget to move on.

(N10,N11,N12)

(N4,N5,N6)

Almost winner, a little bit sad.Also coop well and resp fast.

Interrupter(*make noises by playing the musical instruments*): N3,N10,N12

Respond fast but cooperation not so good. N10 pick the card and move, at the beginning N12 just watching, then N11,N12 take instrument, N11 is not so useful.

Smiling and Running to the

"Is that him?"—tone (positive inpression)

First time know that Shybo would turn into red if there is too much noise.

Beat the table strongly.

First time presentation of how to train Shybo.(Sensor is not opened.)

Dispersion and agitated.

(Children)

Dispersion during the training procedure, others do not focus and talking whne one group is learning how to train Shybo.

Put up their hands when tutor is going to choose next group to train Shybo.

Attitude to be engaged +.

Most of them try to grab the dices(which they call it Shybo's baby.)

Attitude to be engaged +

Procedure is too long, all the children want to be participated, but not possible, one by one.

Not clear about what to do or what they are doing at the beginning. Even for group that has recorded the sound, they have no idea how to check the color, but follow tutor's instruction, and thinking another thing (Eg, N2 asked"Why it

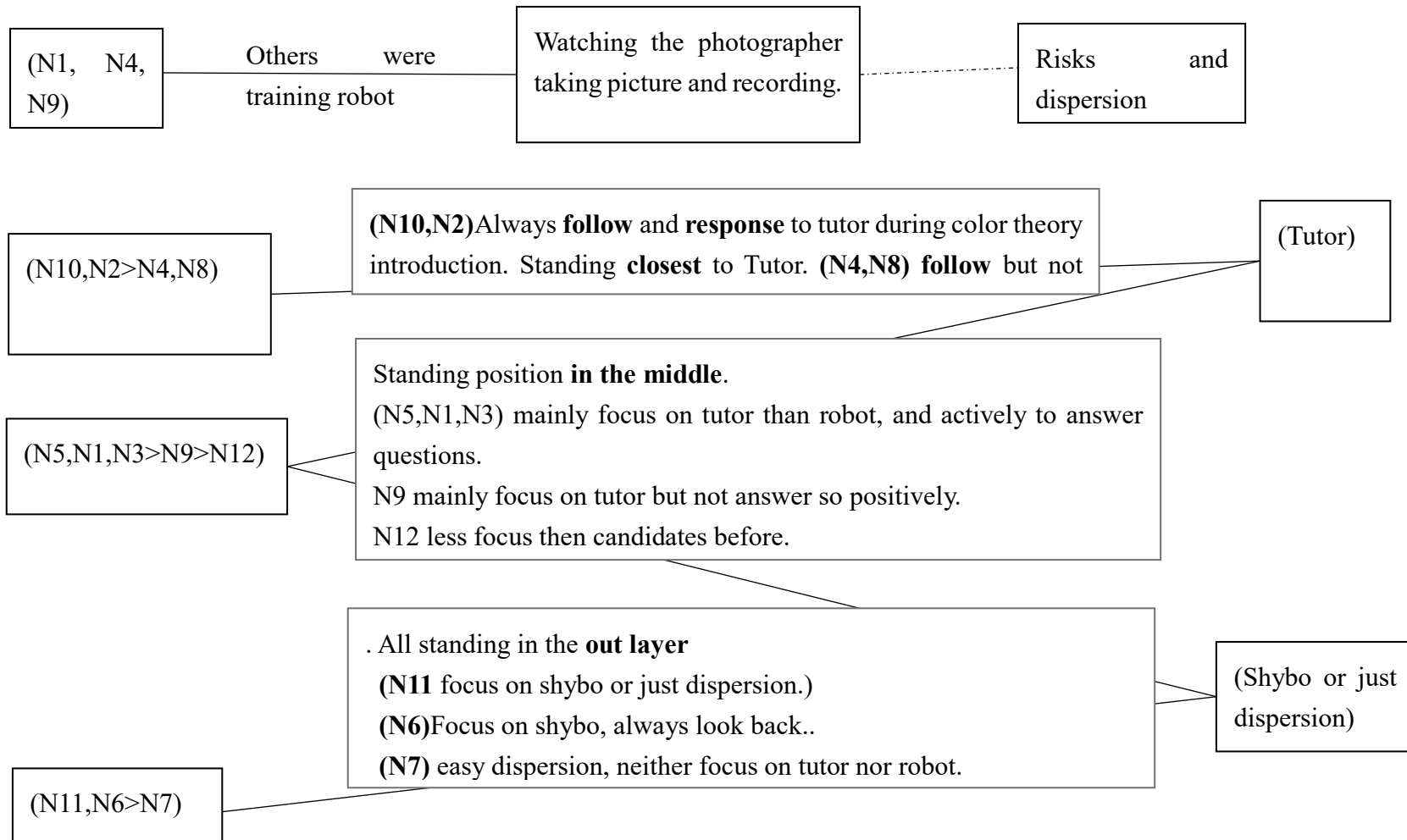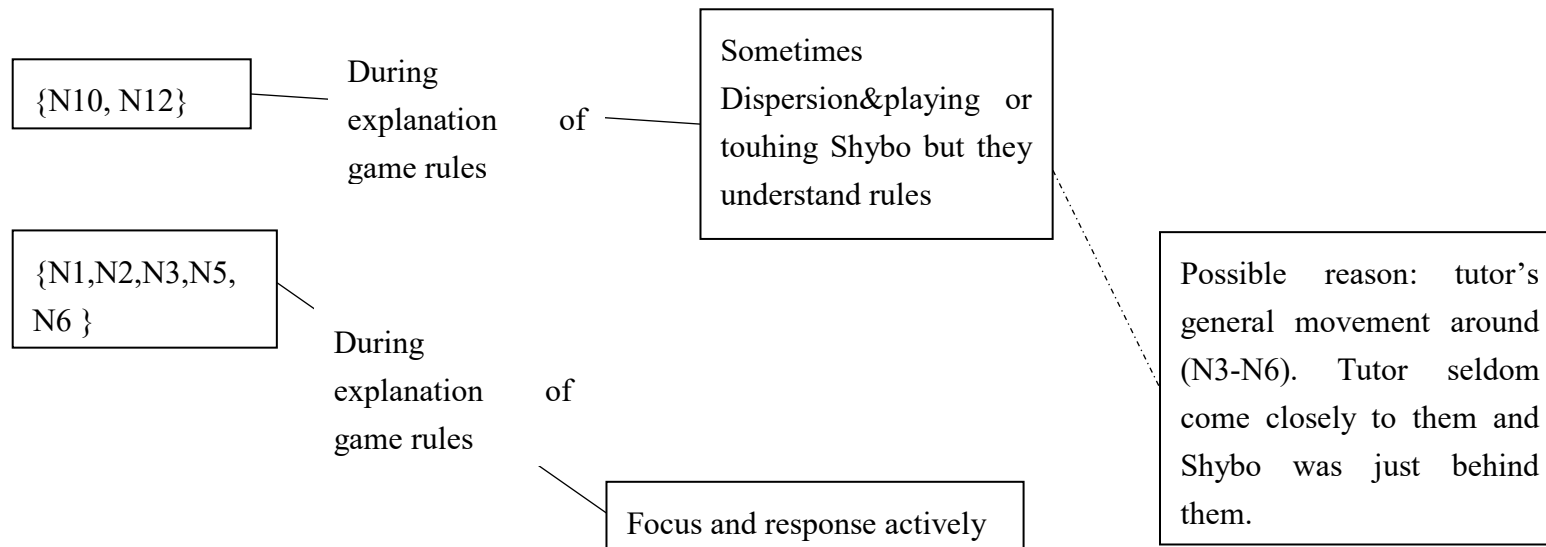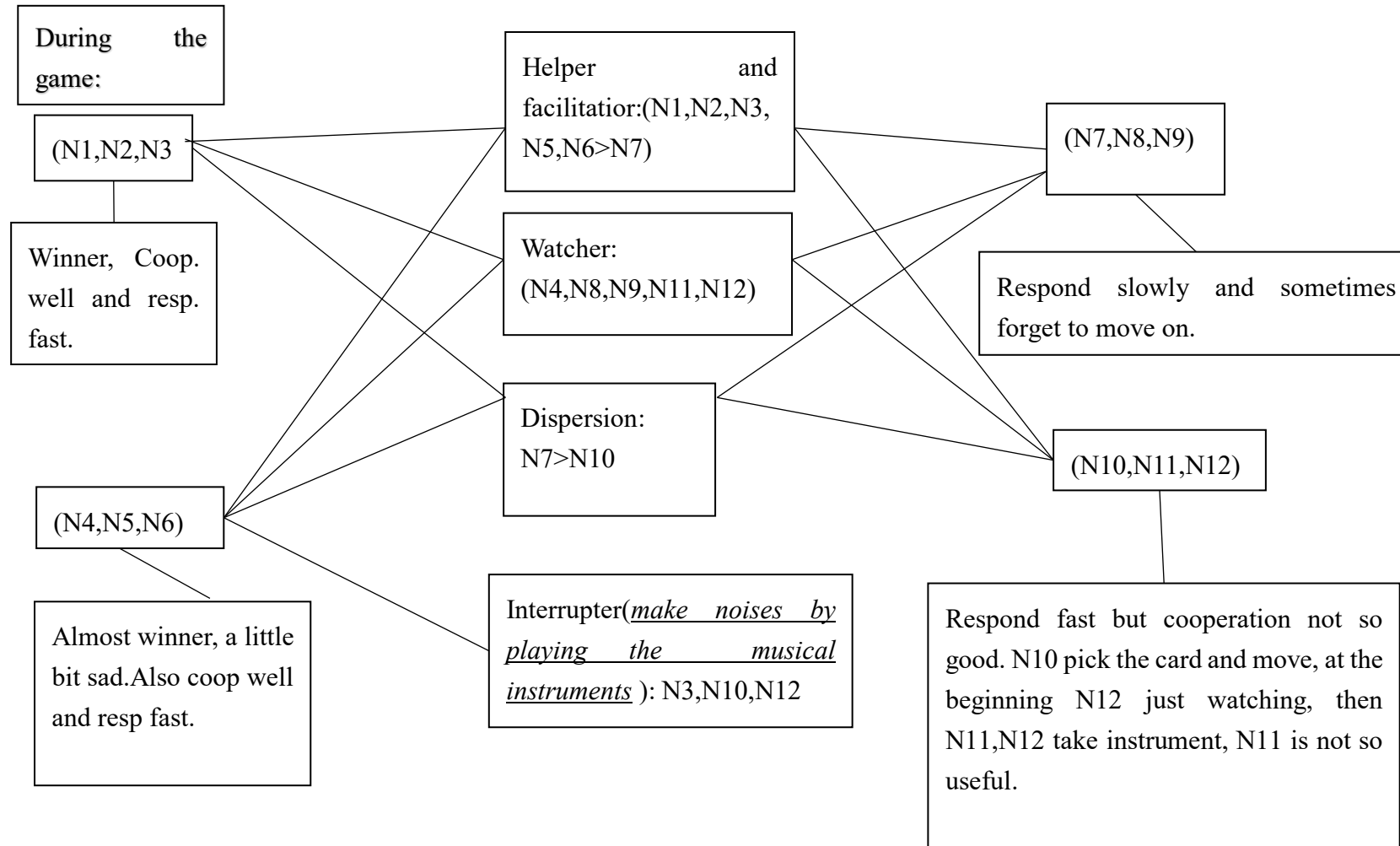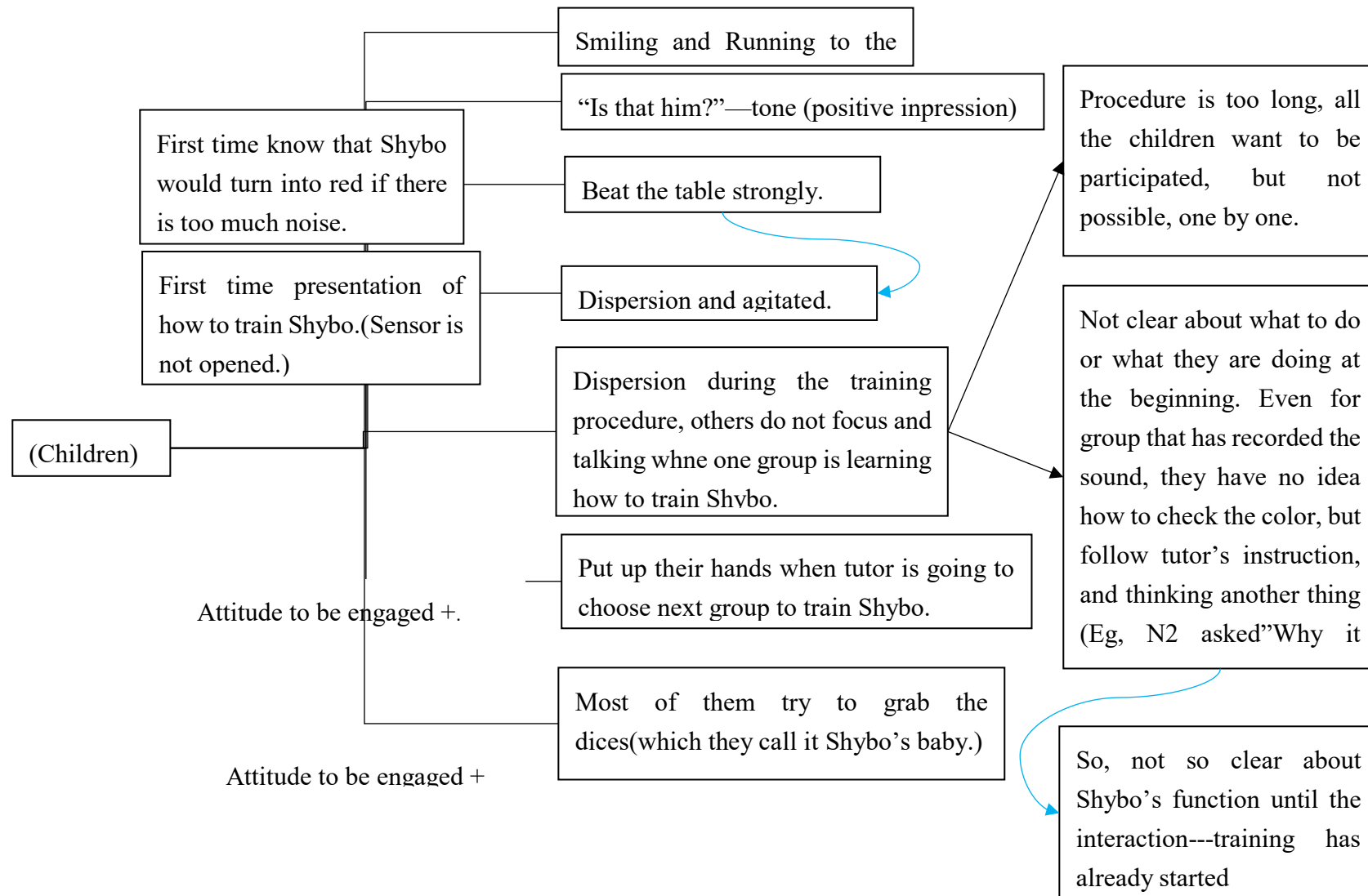So, not so clear about Shybo's function until the interaction---training has already started

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