iNNOVATIVE
iNTERACTIVE
iNTERFACES
Laboratory

POLITECNICO
MILANO 1863

MuseX
MR Museum project

Advanced User Interface Project 2020/2021

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Abstract

MuseX is an interactive Multi-Sensory Environment (iMSE) that offers an immersive learning experience to the primary schools' children and an opportunity to the teacher to make the teaching proposal more differentiated and enjoyable. MuseX aims at reproducing the typical environment of a Natural History Museum enriching it with interactive activities involving physical and non-physical assets. It has been implemented to work into the environment provided by Politecnico di Milano - i3lab's MagicRoom. Thus, the interactions between the children and the software proposed are related to the technologies provided by the laboratory. This documentation goes on the details about the analysis of the specifications and provides a description to the solution adopted both on a User Experience point of view and an implementation insight.

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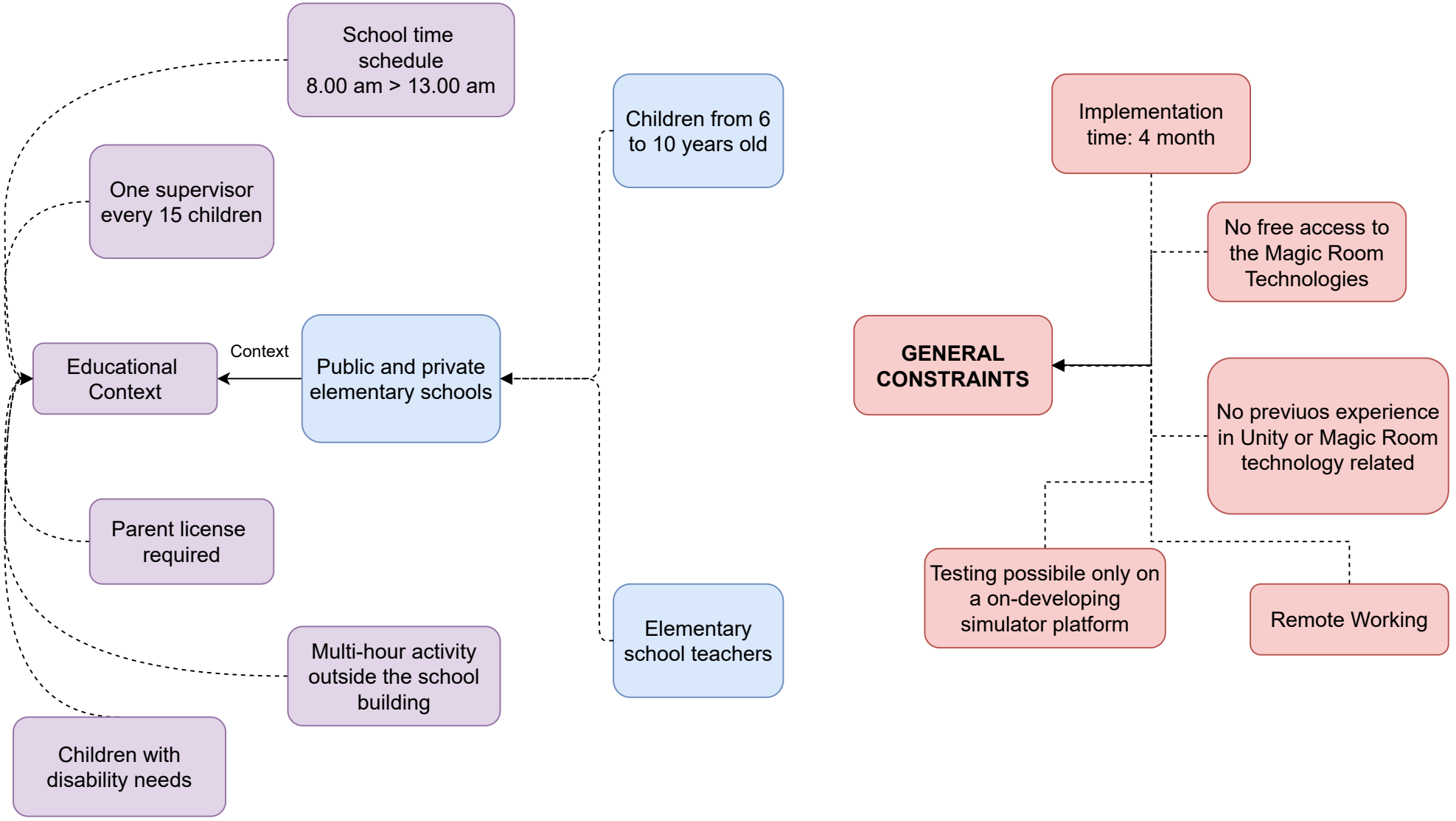
1. Introduction

The Magic Room (MR) is an Interactive Multi-Sensory Environment (iMSE): a room-sized interactive installation equipped with digitally enriched physical materials and ambient embedded devices, capable to perceive the presence and the gestures of one or more human beings, and with the capability to react to these stimulations enabling the already cited embedded devices. On most of the cases iMSEs are used in primary education targeting especially children with Neurodevelopmental Disorders (NDD) relying on the embodied cognition's milestone for which learning is both an intellectual and a physical process. The Magic Room applies in this field and, especially for the latest version of it, the vision is enlarged to all the children, with or without NDD. The aim of the project is to propose a disruptive idea of a museum, completely disconnected to the physical space and transferred to the iMSE. The children, into this interactive space, can learn, socialize, satisfy the curiosity and have fun. On the other hand, the primary school teachers, could differentiate the teaching proposal while proceeding to provide the educational contents and attract their pupils on alternative and more interactive environments, rather than the classic school's room. In this scope we focused on the Natural History Museum in which children could interact with many types of rocks, birds, and various types of habitats' dioramas: applying what they did learn at school and learning new things.

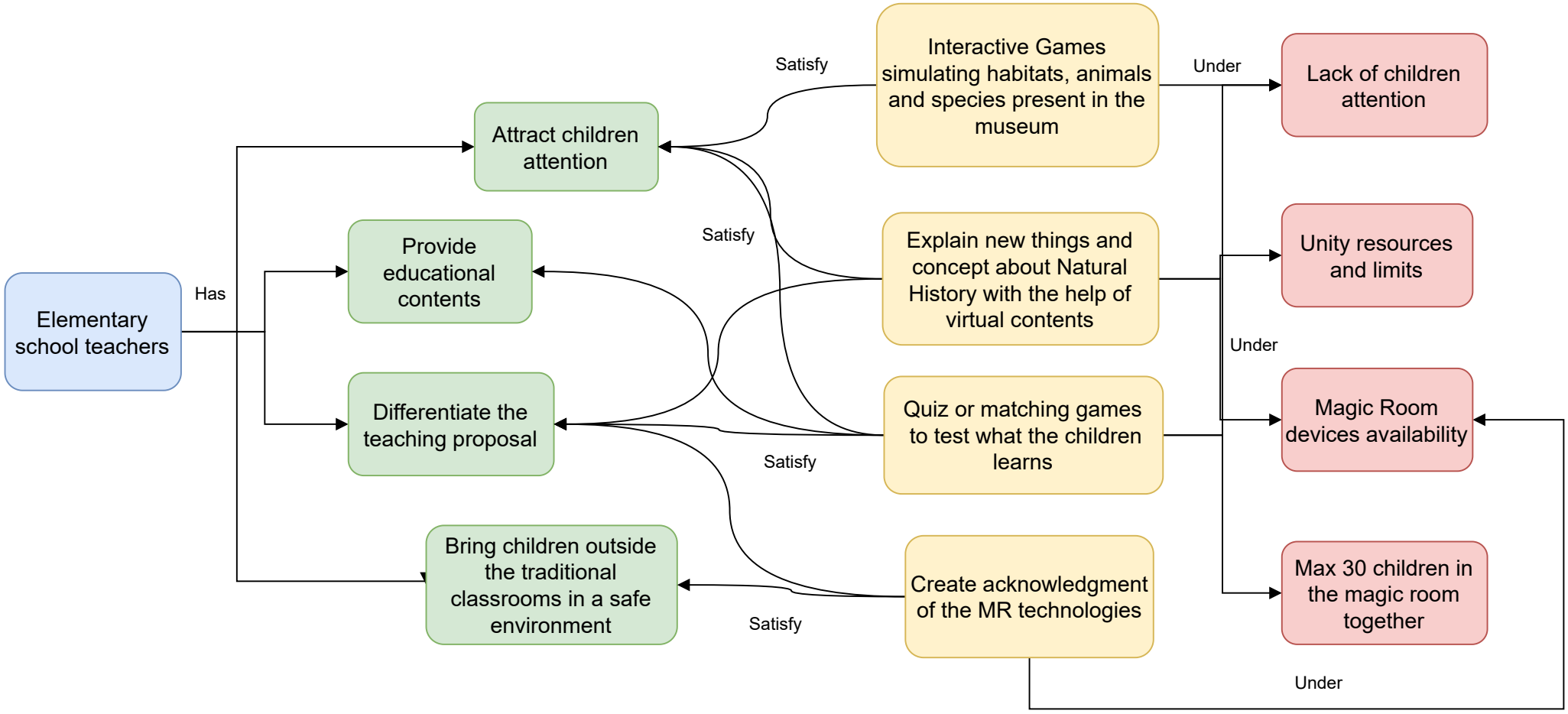
2. Target Groups and User Needs - UNG MODEL

Our UNG analysis is mainly focused on three different stakeholders, namely **children from 6 to 10 years old** and **elementary school teachers.** In the first Diagram we are going to present the context of these stakeholders and the **general constraints** of our project.

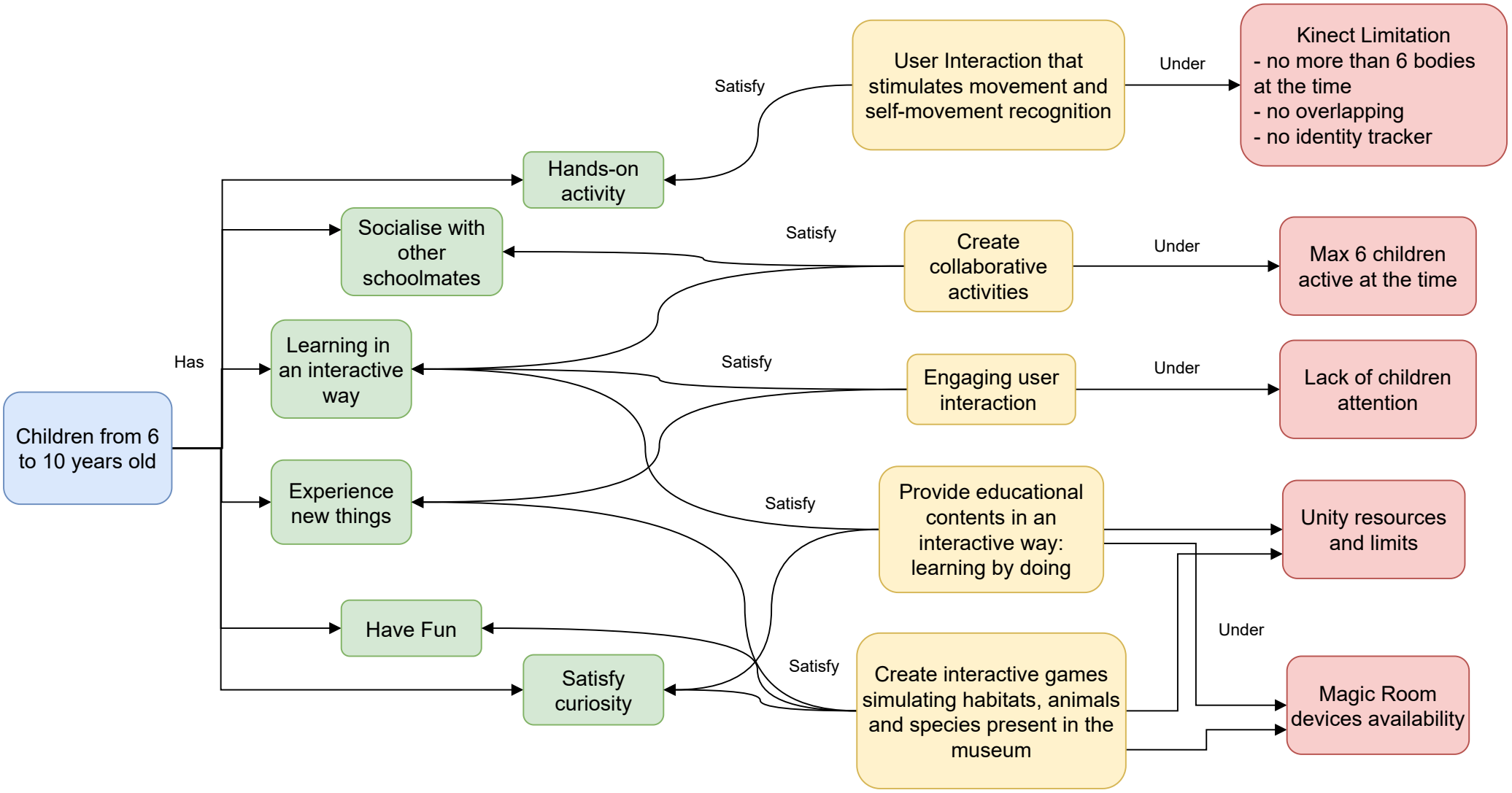


In the next diagrams **each stakeholder is analysed in depth**: needs and goals are specified and the constraints presented are related to the specific stakeholder.

Elementary school teachers



Children from 6 to 10 years old



3. State of the art

Our main technology is the Magic Room that provides many different sensory stimuli to the children that take the tour inside the museum and play the designed games. We haven't found anything in the research or market arena that is based on this technology, however there are some examples of virtual museum tours designed as Web App, therefore available from the PC and the Smartphone. The most important thing to highlight is that the high majority of these projects is not targeting in specific the children needs and eventually none of them is targeting also children with NDD in order to provide them help in the rehabilitation process.

Some examples:

1- THE BRITISH MUSEUM:

Best for**:** Kids ready to explore a more interactive experience

Ever wanted to see the Rosetta Stone or a real-life mummy? Look no further than the British Museum, which you'd usually have to seek out during a vacation in London. The tour is interactive, with artifacts searchable by era, region or type, and you can discover all sorts of interesting objects, including a bank check from Barclays and a papyrus poem from ancient Egypt.

Considerations: Experience for kids, but no features for NDD children, no rich sensory stimuli, no natural history.

2- THE METROPOLITAN MUSEUM OF ART

Best for**:** Future time travelers

New York's Met Museum has an entire section of its website dedicated to young ones called MetKids. The online-only experience features a time machine, where you can search by time period, idea or location to uncover objects and artwork from the museum's rooms. The "Big Ideas" search tool allows kids to look into topics like inventions, fashion and battles, and see all the relevant artifacts—a cool way to learn without it really seeming like you're learning. There are also videos, as well as an interactive map of the museum that allows you to check out various exhibitions around the building.

Considerations: Experience for kids, but no features for NDD children, no rich sensory stimuli, no natural history.

3- BOSTON CHILDREN'S MUSEUM

Best for: Mimicking the real thing

A children's museum would be the best place to take the kids when they're off from school, but a virtual experience will have to do for now. The Boston Children's Museum welcomes online visitors into its exhibits (no lines!) and you can supplement the images with your own at-home activities and games.

Considerations: Experience for kids, but no features for NDD children, no rich sensory stimuli, no natural history.

4- SMITHSONIAN NATIONAL MUSEUM OF NATURAL HISTORY

Best for: An all-encompassing educational experience

Take yourself on a tour of the Smithsonian National Museum of Natural History, whether it's through the temporary exhibitions or the permanent collection. Along the way, check out dinosaur skeletons, animals from around the globe and even past exhibits that are no longer on display in reality. It's a great way to keep your kids learning about the world around them even when they can't be in school, and there are plenty of follow-up activities or readings you can do after the tour. While you're there, stop by the Smithsonian Castle and the Hirschhorn Sculpture Garden, both of which have adjoining virtual tours.

Considerations: Experience for kids, natural history museum, but no features for NDD children, no rich sensory stimuli.

There are also some sites that provide some ideas of games to play with children when they are driven to a museum in order to make them learn things in fun ways. Here is an example: https://www.playfullearning.net/resource/6-games-play-child-museum/

The descriptions of the museums are taken from this site: https://www.purewow.com/family/virtual-museum-tours-for-kids

4. UX Design

MuseX, as an iMSE, exploits a full body interaction paradigm, resulting in an experience that involves many physical ways to interact with it through the body. In the course of this section, we will exploit the ISS model in order to provide a model of the user experience. The first one we will expose is the Capability Model, which aims at describe all the possible interactions that can be done by human and not-human actors among the activity. This is strictly related to the devices provided by the MR so an eventual enlargement of the capabilities would require an enrichment of the MR's devices too. Then, the dynamic interactive behaviour, is described with the Interaction Behaviour Model. Here, the interaction during the activity is exposed via tasks that can require to be performed by both the human and not-human actors.

4.1 ISS Model - Introduction

In the following pages the ISS model of the whole activity is presented in this order:

1. Capability Model

1a) Actor Model

1b) User Action Model

2. Behavioral Model

2a) MR Museum Activity Model with expanded user tasks

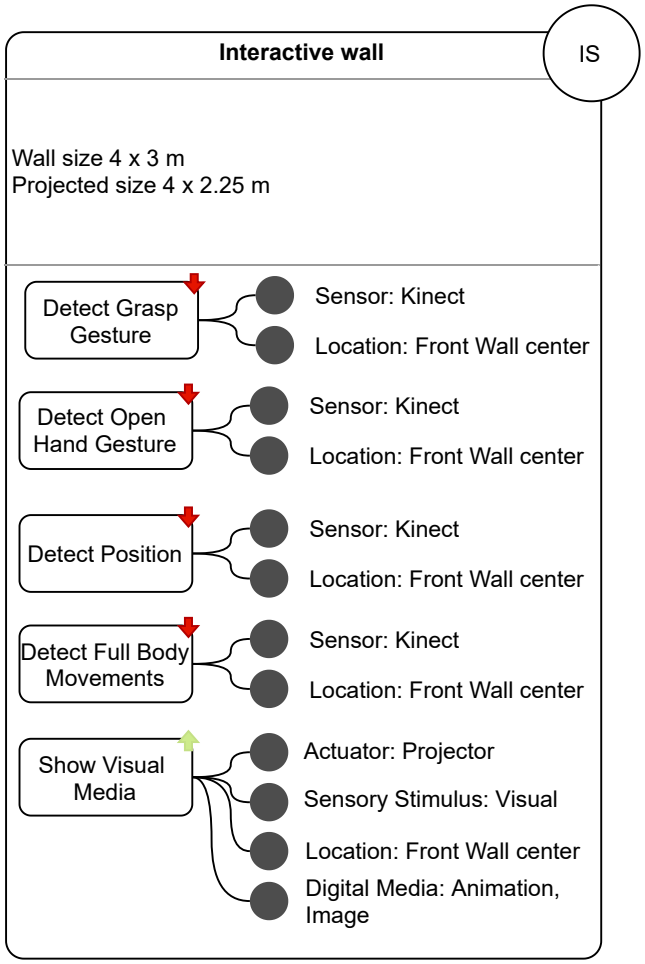
2b) Mini Game - **Matching the habitat:** description, Activity Model and expanded user tasks and effects

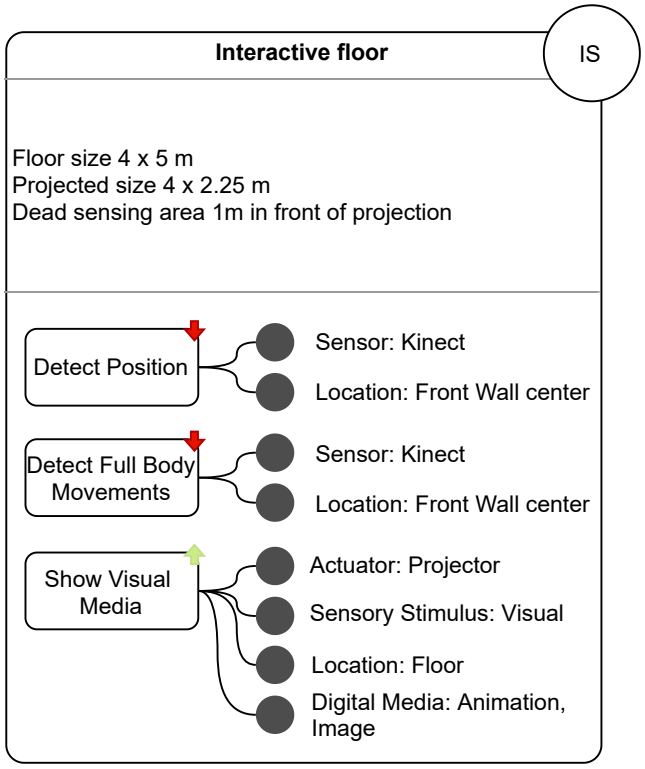
2c) Mini Game - **I'll catch you, big bird:** description, Activity Model and expanded user tasks and effects

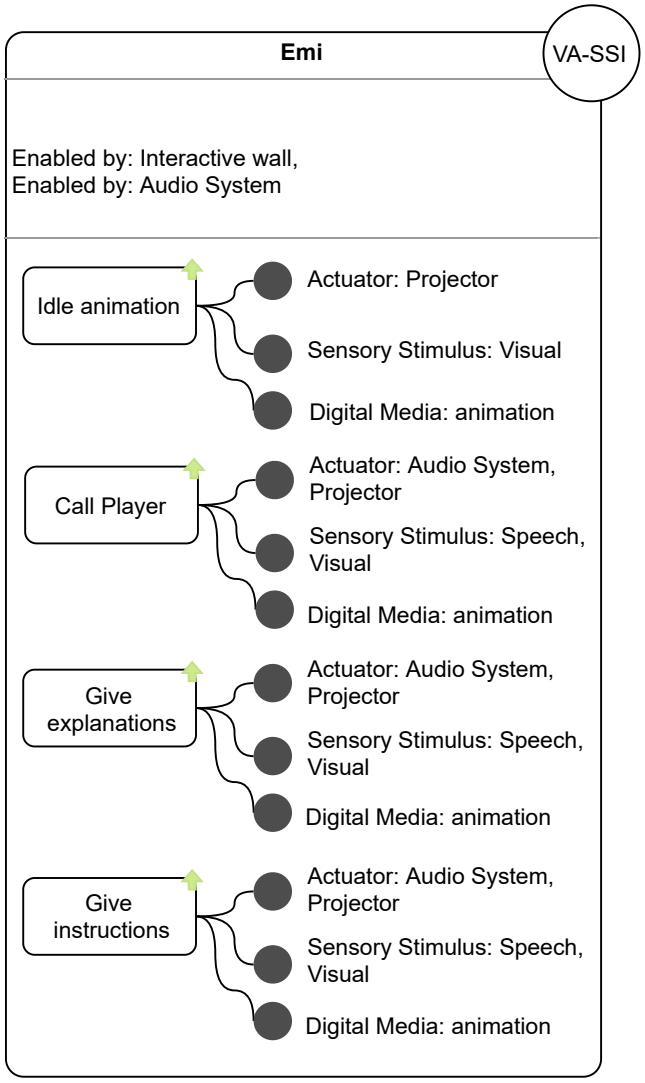
2d) Mini Game - **Little geologist:** description, Activity Model and expanded user tasks and effects

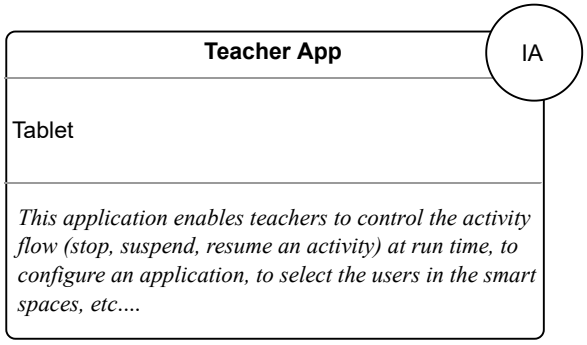
This symbol in the ISS Model is being used to underline that the user task is done without the use of technological devices

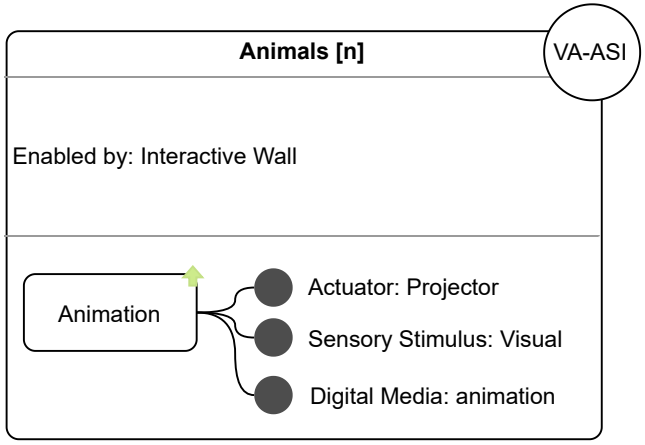
4.2.1 Capability Model - Actor Model

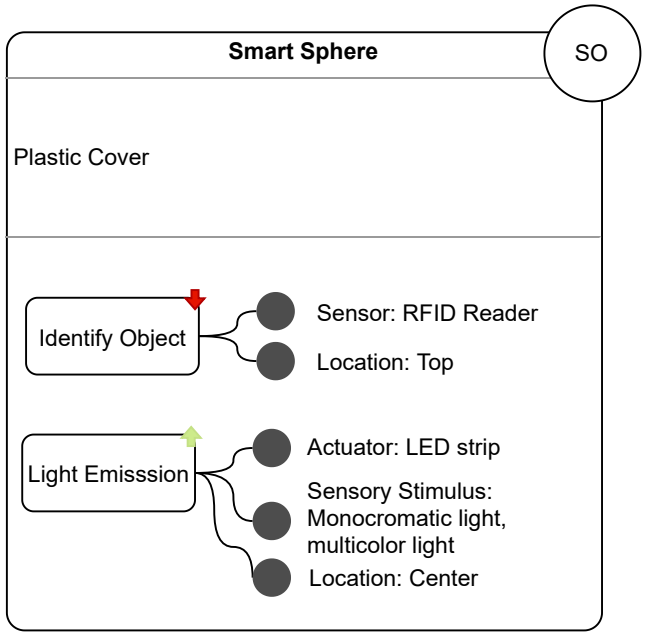


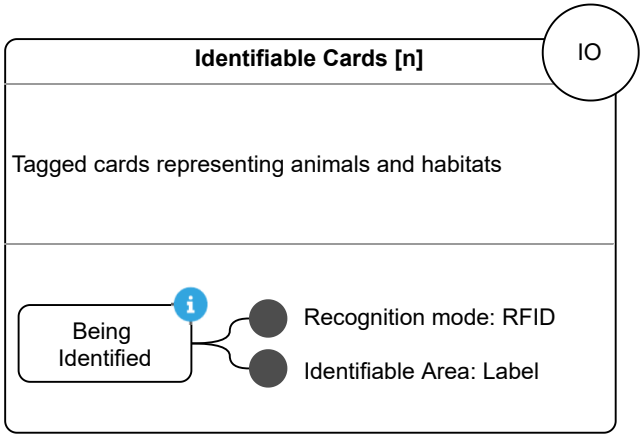


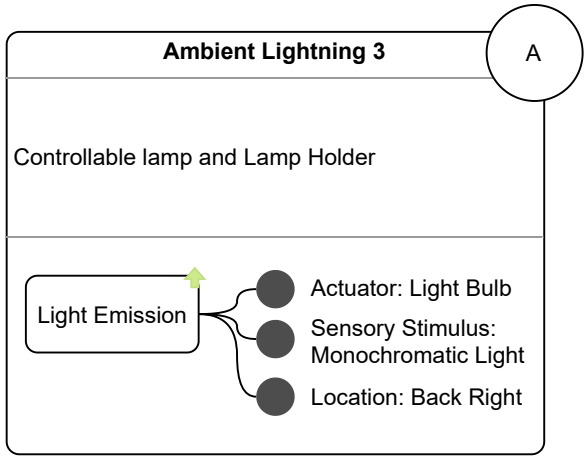


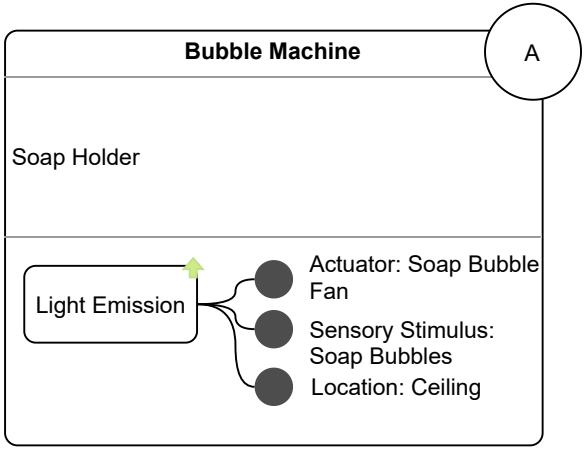


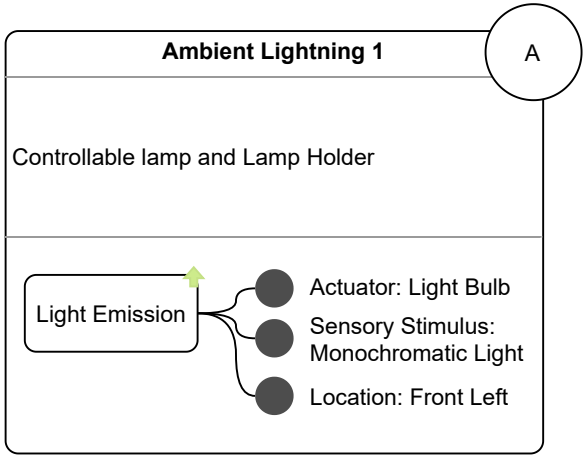


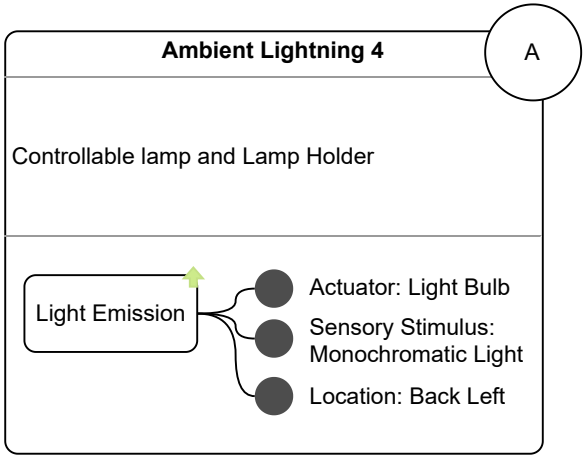

Smart Sphere
SO
Plastic Cover
Identify Object
Sensor: RFID Reader
Location: Top
Light Emisssion
Actuator: LED strip
Sensory Stimulus: Monocromatic light, multicolor light
Location: Center

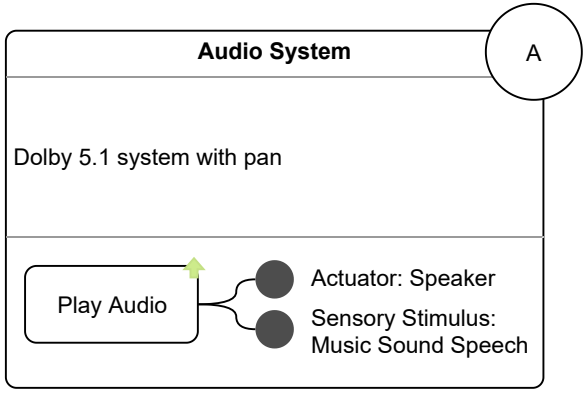

Identifiable Cards [n]
IO
Tagged cards representing animals and habitats
Being Identified
Recognition mode: RFID
Identifiable Area: Label

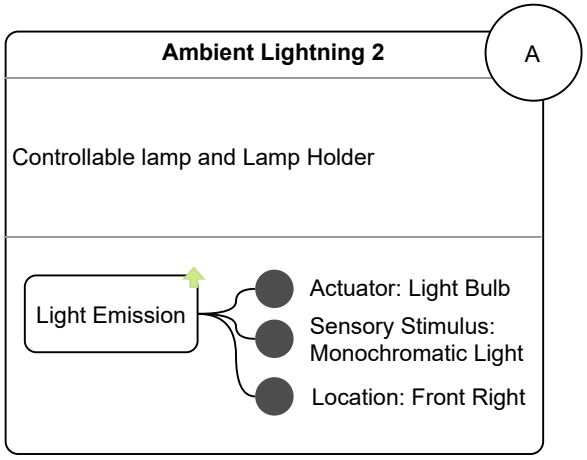

Ambient Lightning 3
A
Controllable lamp and Lamp Holder
Light Emission
Actuator: Light Bulb
Sensory Stimulus: Monochromatic Light
Location: Back Right


Bubble Machine
A
Soap Holder
Light Emission
Actuator: Soap Bubble Fan
Sensory Stimulus: Soap Bubbles
Location: Ceiling

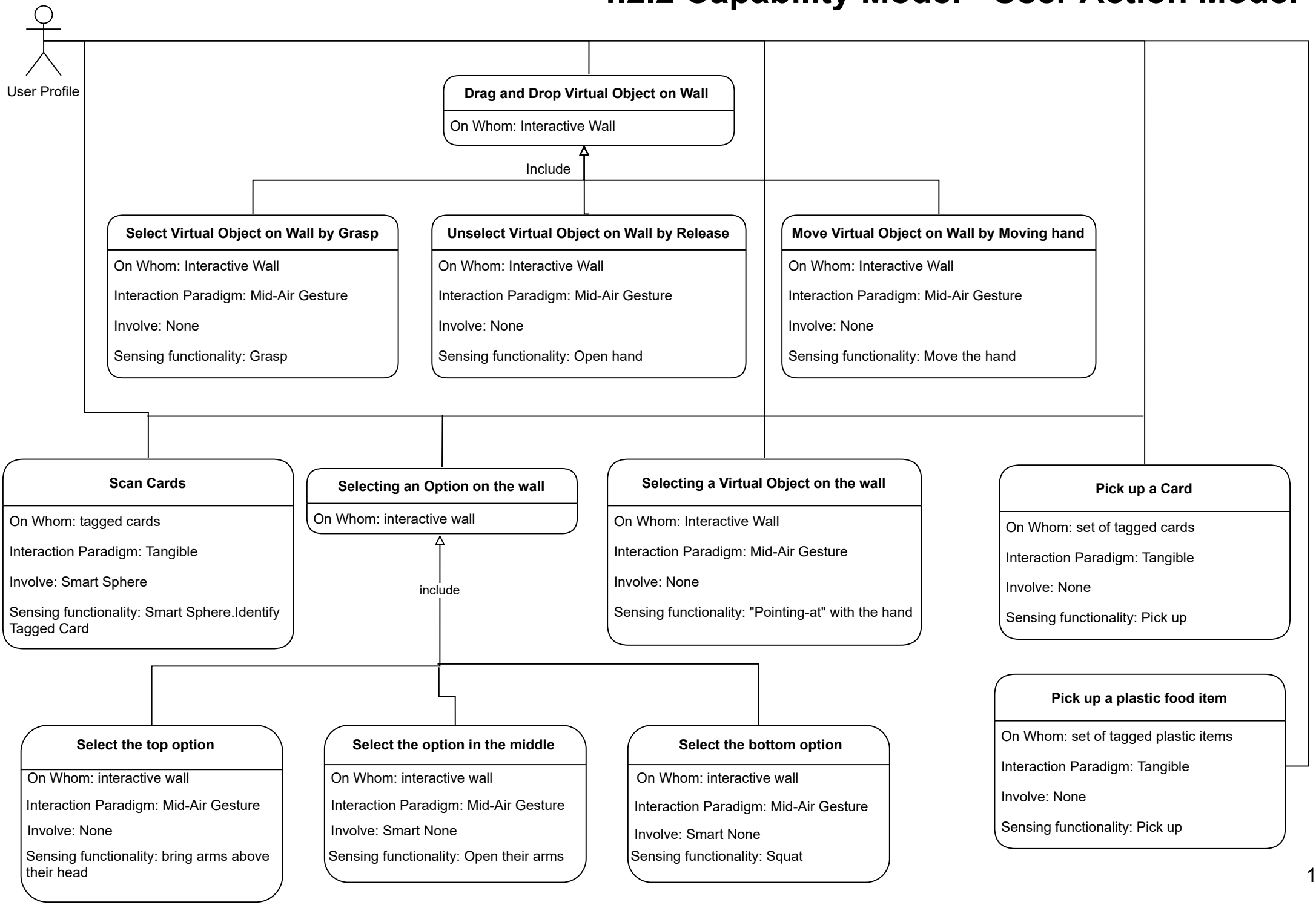

Ambient Lightning 1
A
Controllable lamp and Lamp Holder
Light Emission
Actuator: Light Bulb
Sensory Stimulus: Monochromatic Light
Location: Front Left


Ambient Lightning 4
A
Controllable lamp and Lamp Holder
Light Emission
Actuator: Light Bulb
Sensory Stimulus: Monochromatic Light
Location: Back Left


Audio System
A
Dolby 5.1 system with pan
Play Audio
Actuator: Speaker
Sensory Stimulus: Music Sound Speech


Ambient Lightning 2
A
Controllable lamp and Lamp Holder
Light Emission
Actuator: Light Bulb
Sensory Stimulus: Monochromatic Light
Location: Front Right

4.2.2 Capability Model - User Action Model

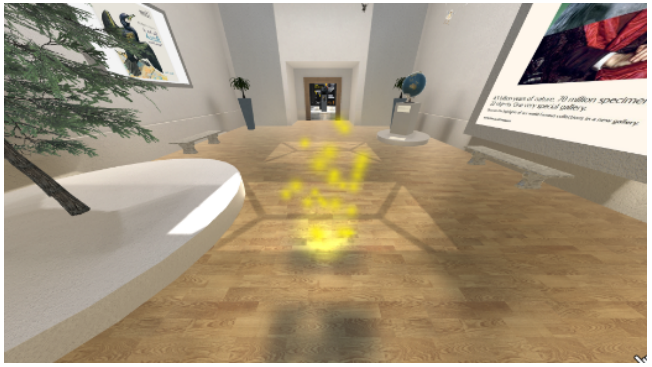


4.3.1 ISS Behavioural - MuseX Activity Model

4.3.1.1 Overview

Here we present the activity that embraces all the other mini-games. We called it "Navigation": in order to remind that the movement inside the musuem is an adventure itself. Indeed, during the Navigation, the child can rotate the displayed visual of the front wall through a drag-and-drop gesture in order too discover every secret that the muesum hides under the hood such as mini-games, dioramas and informational panes distributed around the museum. To move inside the MuseX, a child has to be elected among the ones in the class and has to stand inside a blue circle projected onto the floor and do a step following the direction suggested by the projected arrows (see the next page for more details). When she/he will return back to the circle, the animation will begin. The points of the MuseX in which there is a mini-game to play, are visible by an animation. When the class is virtuallly into those points, a star will appear on one of the 4 directions and, by stepping over the star such as described before for the movement, the mini-game will start. Emi has the role to guide the class, we refered to it as the "Virgilio" of the activity. Indeed, Emi welcomes the class into MuseX and is always ready to give further explanations for example when it comes the moment to play to a mini-game.

The Navigation system is based on a set of software components called "Waypoints". Without entering into the details of the implementation (there is a paragraph concerning this subject later on), it is important to underline that there are only a set of pre-defined positions (see the green circles on the map below) in which the child can choose to move. This possibility is always presented by the arrows. So, for example, if there is an arrow projected in front of the child by the floor projector, that means that there is a waypoint in front of him in the virtual environement and that if she/he steps forward than the animation will bring the classroom into the nearer front waypoint. On the contrary, if for a certain direction there is no arrow, that means that the movement can not be done in that direction because there is no near waypoint in that direction. On the previous page there was presented an interaction with a star in the floor. Indeed, there are certain Waypoints into the MuseX (see below) that are characterized by a corpuscolar animation and those positions allow the class to participate to the games. Finally, while the Navigation occurs, there are spots in the virtual environement, identified with a "i" icon, that can contain additional contents (see the image below) such as informations about the animals in the dioramas or something related to their feedings or habitats. To interact with this pillows of knowledge the children has to do a grasp gesture in the direction of the icon.



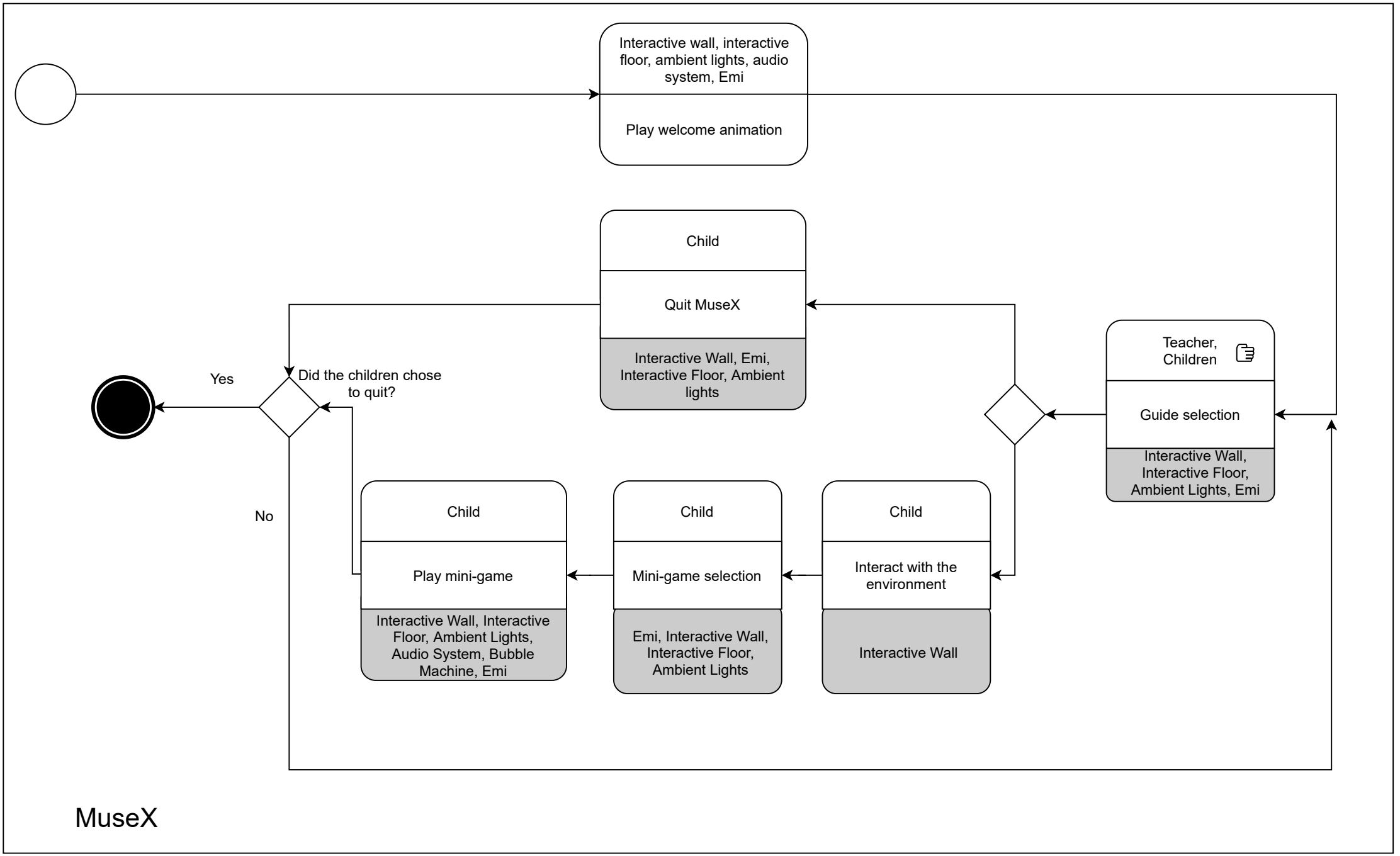
Corpuscolar Animation - image just for explanation purposes

Waypoint Map. Planimetry of the Museum - image just for explanation purposes

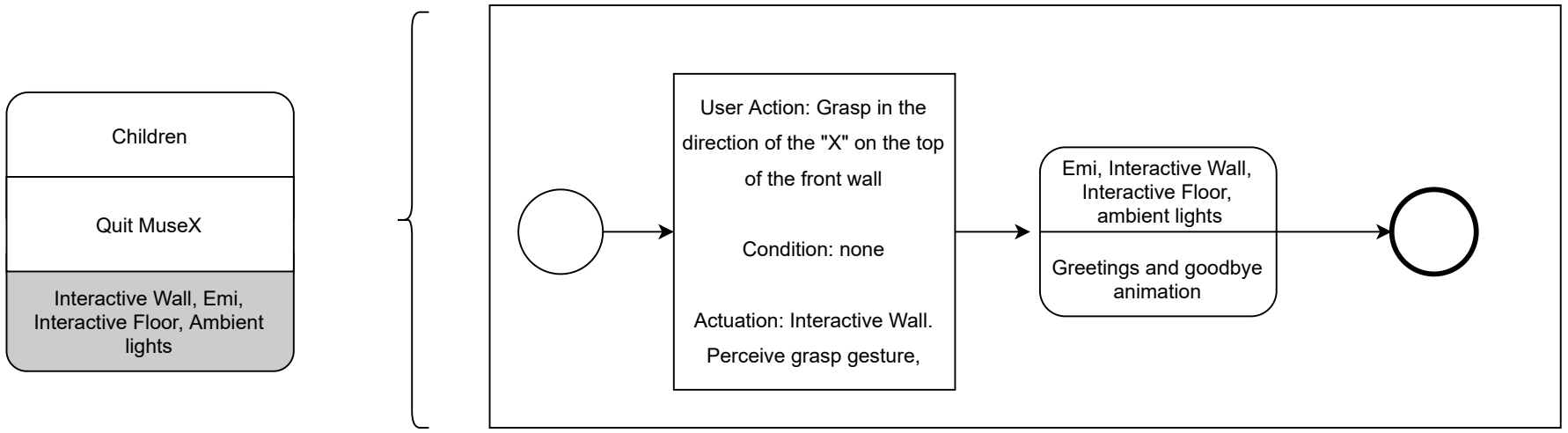
Pillows of knowledge sparse in the museum - image provided just for explanation purposes

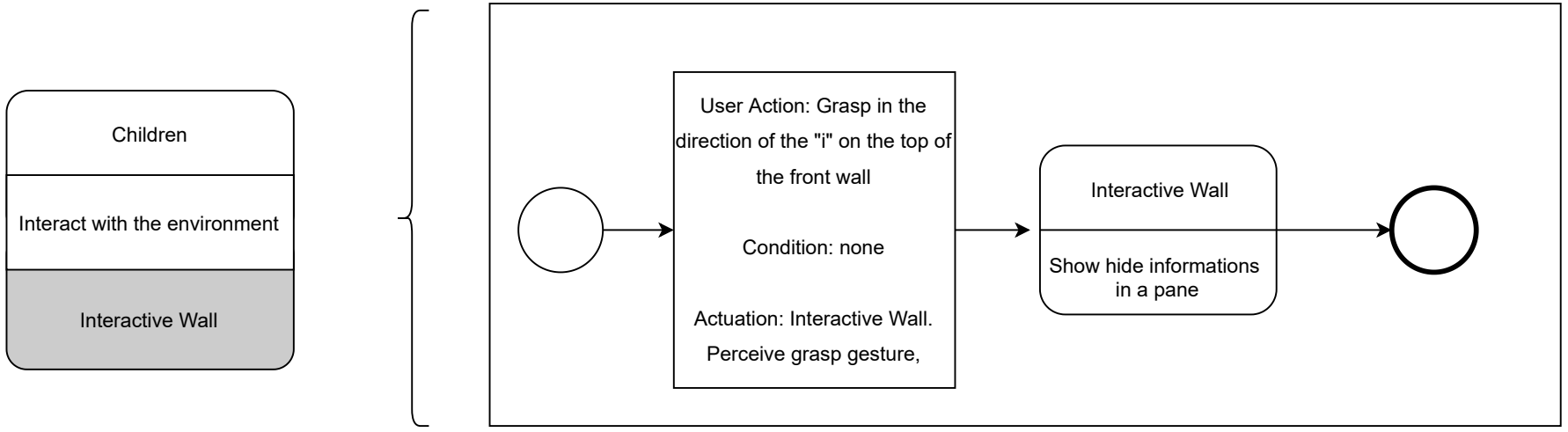
In the next page, it is presented the interactive behavioural model of the Navigation, while in the rest of the section there is a specific interactive behavioural model for each mini-game that can be found into the MuseX. Each of them can be seen as an expansion of the User task "Play mini game", with Children as human-actor, presented on the next page.

4.3.1.2 Interactive Behaviour Model



User Tasks


Children
Quit MuseX
Interactive Wall, Emi, Interactive Floor, Ambient lights
User Action: Grasp in the direction of the "X" on the top of the front wall
Condition: none
Actuation: Interactive Wall. Perceive grasp gesture,
Emi, Interactive Wall, Interactive Floor, ambient lights
Greetings and goodbye animation


Children
Interact with the environment
Interactive Wall
User Action: Grasp in the direction of the "i" on the top of the front wall
Condition: none
Actuation: Interactive Wall. Perceive grasp gesture,
Interactive Wall
Show hide informations in a pane

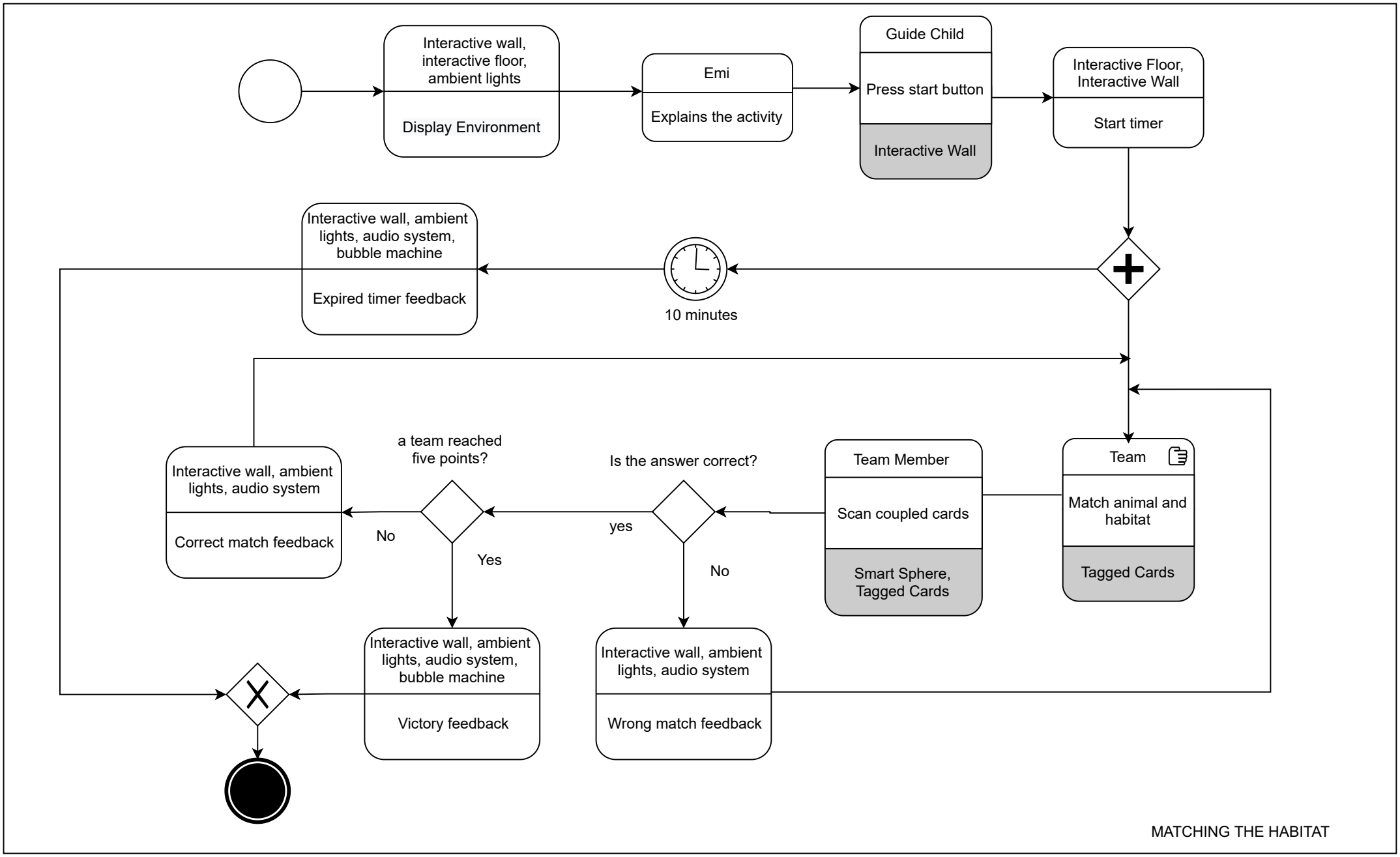
4.3.2 ISS Behavioural - Matching the habitat

The aim of this activity is to test how much children know about animals and their natural habitat. This activity is based on a competition between two teams, namely Team A and Team B. To set up this activity the teacher is required to divide the students in this two teams. The splits is done without any equipment support, just asking the students to move to the left part of the Magic Room for Team A and to the right part of the Magic Room if a child is assigned to Team B.

Two sets of tagged card are prepared for the two teams, each set is identified by a different color and the name of the team on the back and contains both card representing animals and also habitats.

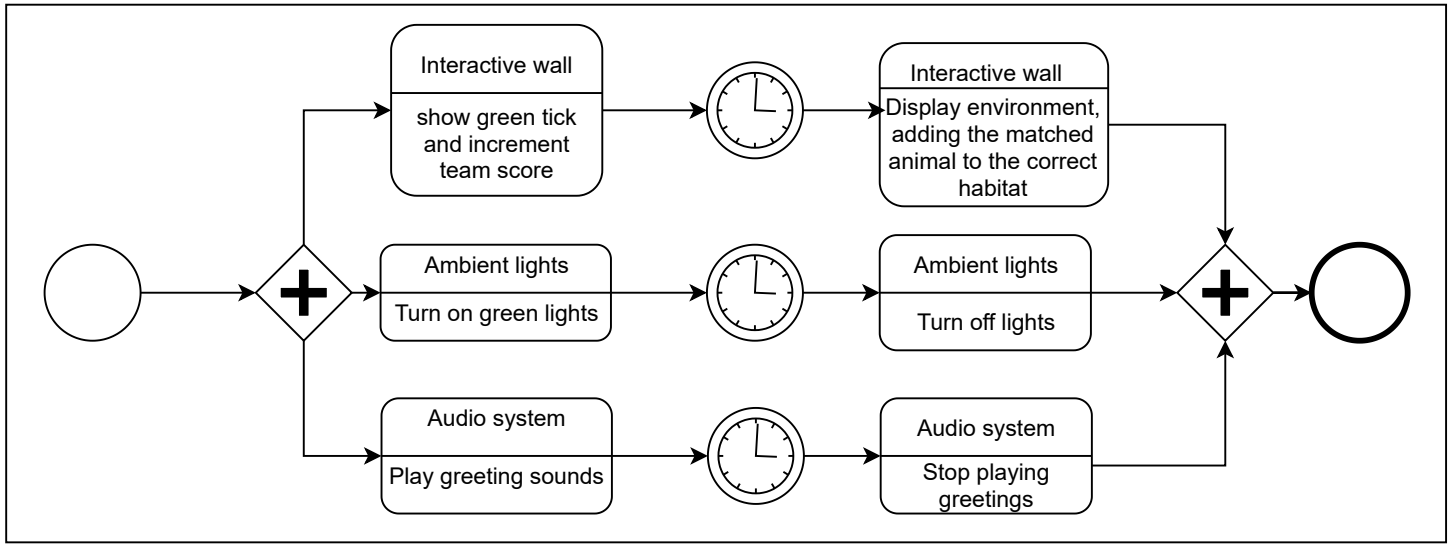
When the activity begins, Emi explains shortly what the children have to do: each teams has to discuss and came up with matched animals and habitat cards. When an agreement is reached by the team member, a team spokesman stands up and scans the coupled animal and habitat card. If the match is correct, the team gains a point. To win, a teams has to reach five points in a given time (10 minutes), displayed in the interactive floor as a timer counting to zero. When a correct match is submitted the room turns green, a greetings sound is played, a green tick is showed in the front wall, and the animal matched appears in its natural habitat. Habitats are displayed on both the interactive wall and floor, and when an habitat card is scanned, the view moves from one habitat to the other. When an incorrect match is submitted, the room turns red and a failure sound is played while the interactive wall shows a red cross. If two animal cards or two habitat cards are scanned together, the room turns red, an error sound is played and an error message shown on the floor. If neither one of the teams reaches five points before the timer expires, the room turns blu, an alarm is played for a few seconds and the bubble machine starts. In this case, the team with more points wins.

Activity diagram

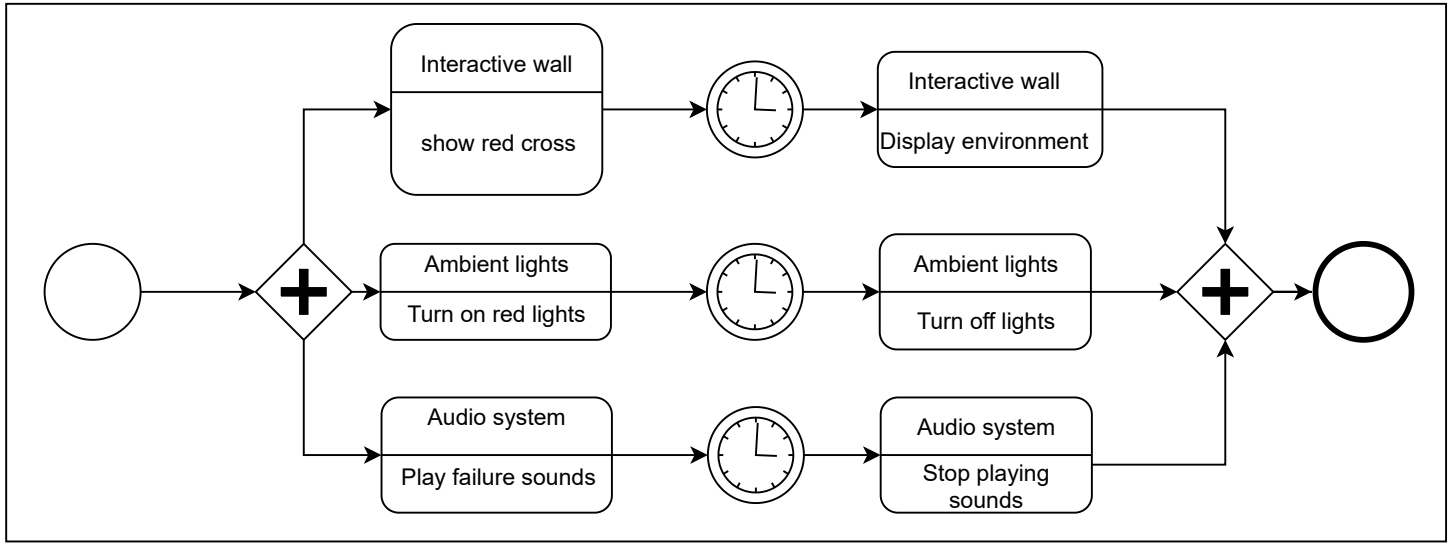


Effects

Interactive wall, ambient lights, audio system	Correct match feedback



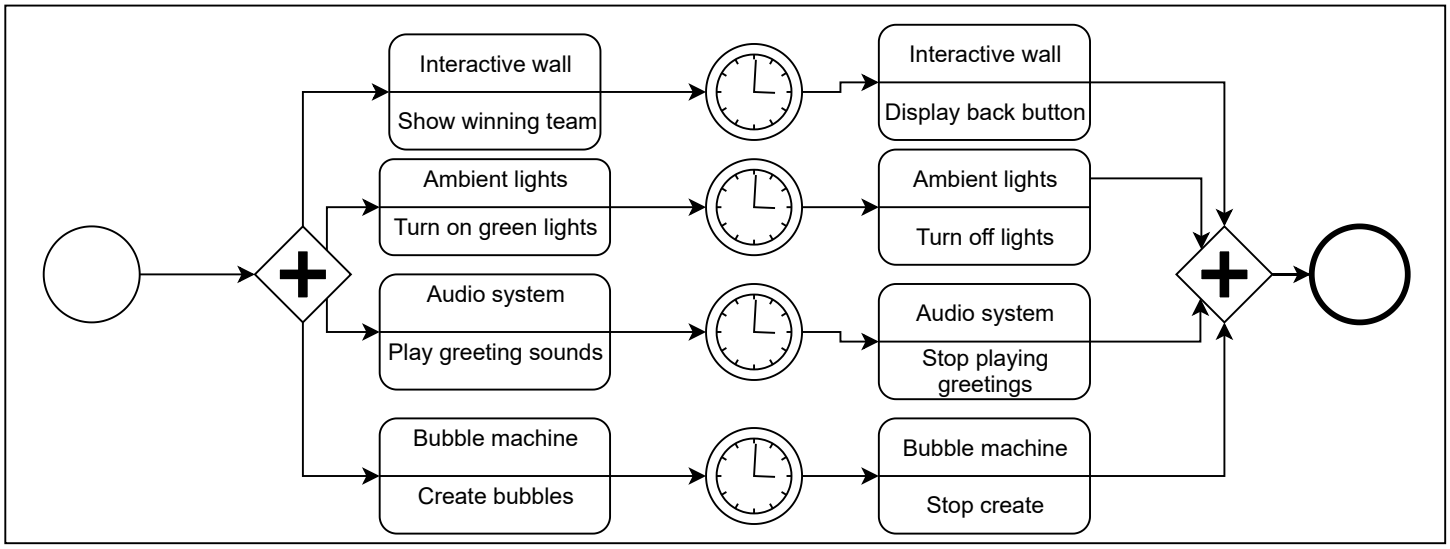
Interactive wall, ambient lights, audio system	Wrong match feedback



***** When not specified differently, the Timer expires after **3 seconds**

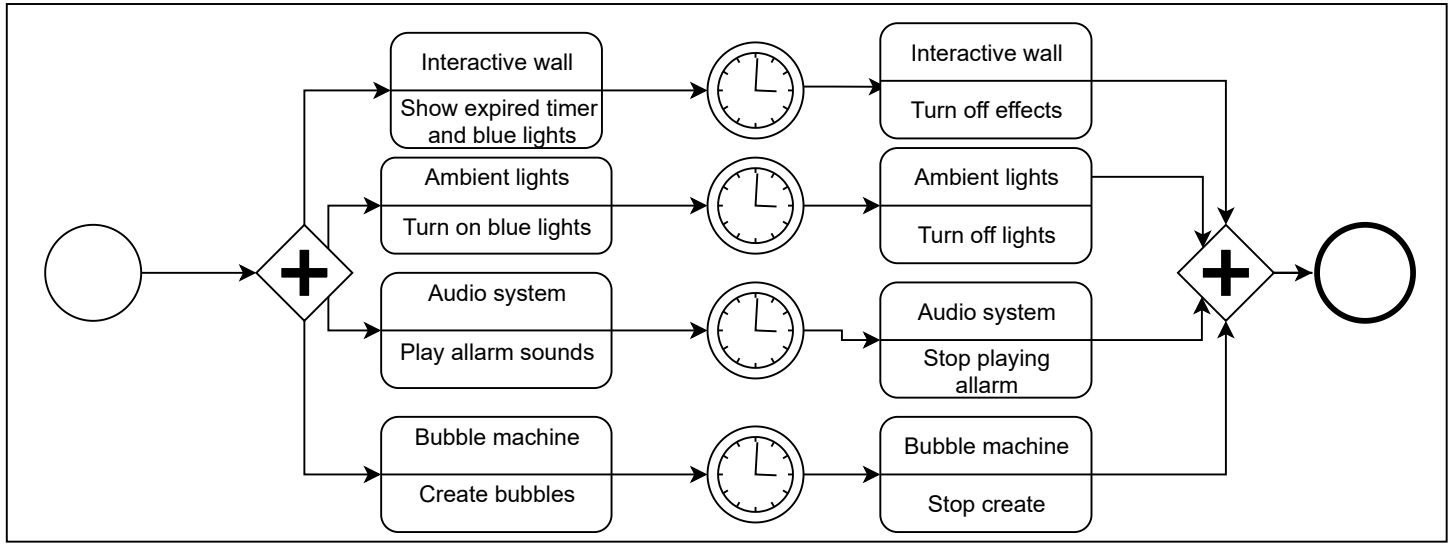
Interactive wall, ambient lights, audio system, bubble machine

Victory feedback

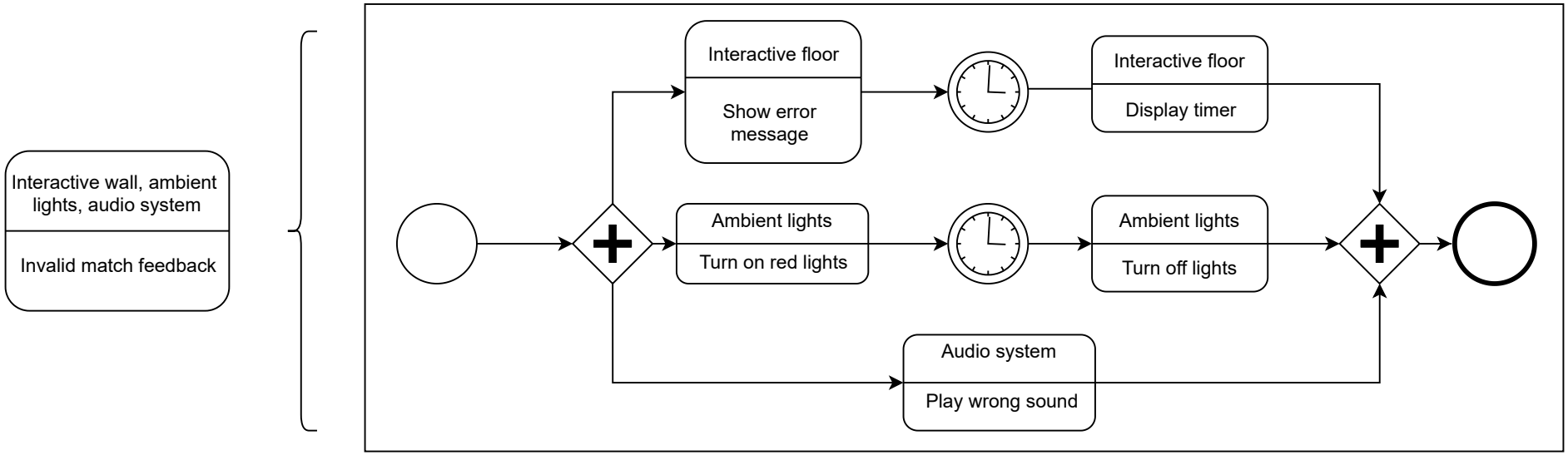


Interactive wall, ambient lights, audio system, bubble machine

Expired timer feedback

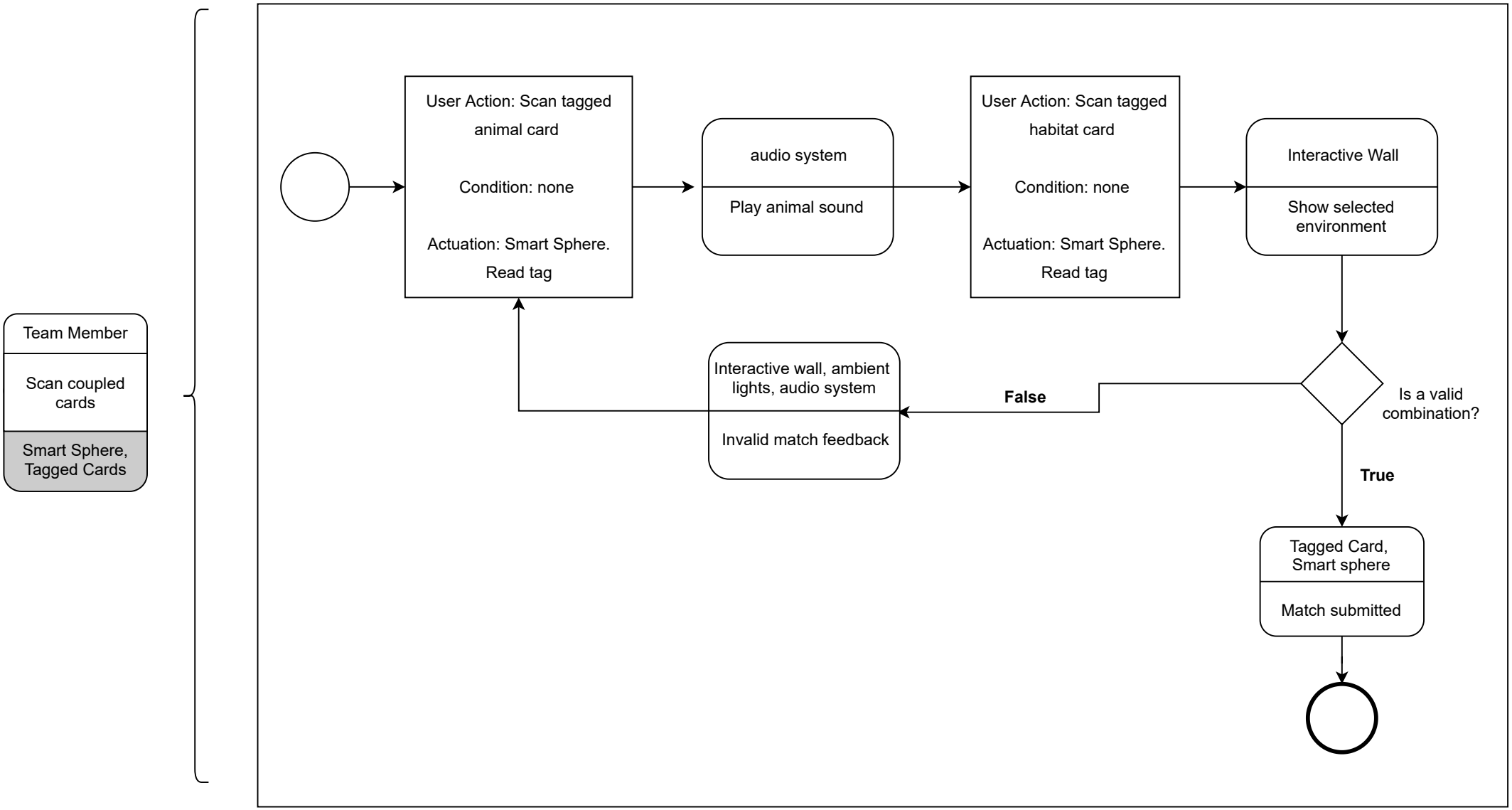


***** When not specified differently, the Timer expires after **3 seconds**



***** When not specified differently, the Timer expires after **3 seconds**

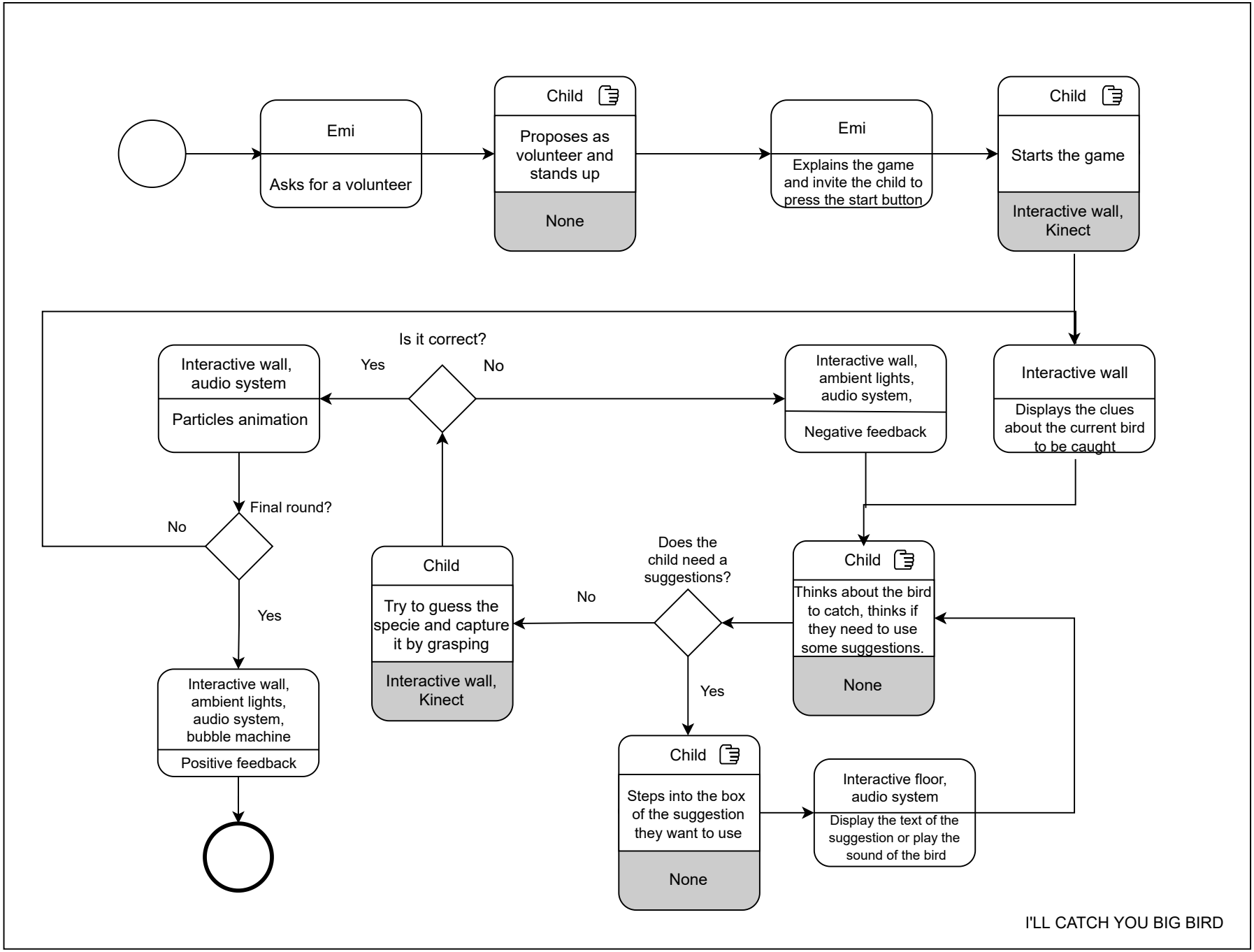
User Tasks


Team Member
Scan coupled cards
Smart Sphere, Tagged Cards
User Action: Scan tagged animal card
Condition: none
Actuation: Smart Sphere. Read tag
audio system
Play animal sound
User Action: Scan tagged habitat card
Condition: none
Actuation: Smart Sphere. Read tag
Interactive Wall
Show selected environment
Is a valid combination?
False
Interactive wall, ambient lights, audio system
Invalid match feedback
True
Tagged Card, Smart sphere
Match submitted

4.3.3 ISS Behavioural - I'll catch you, big bird!

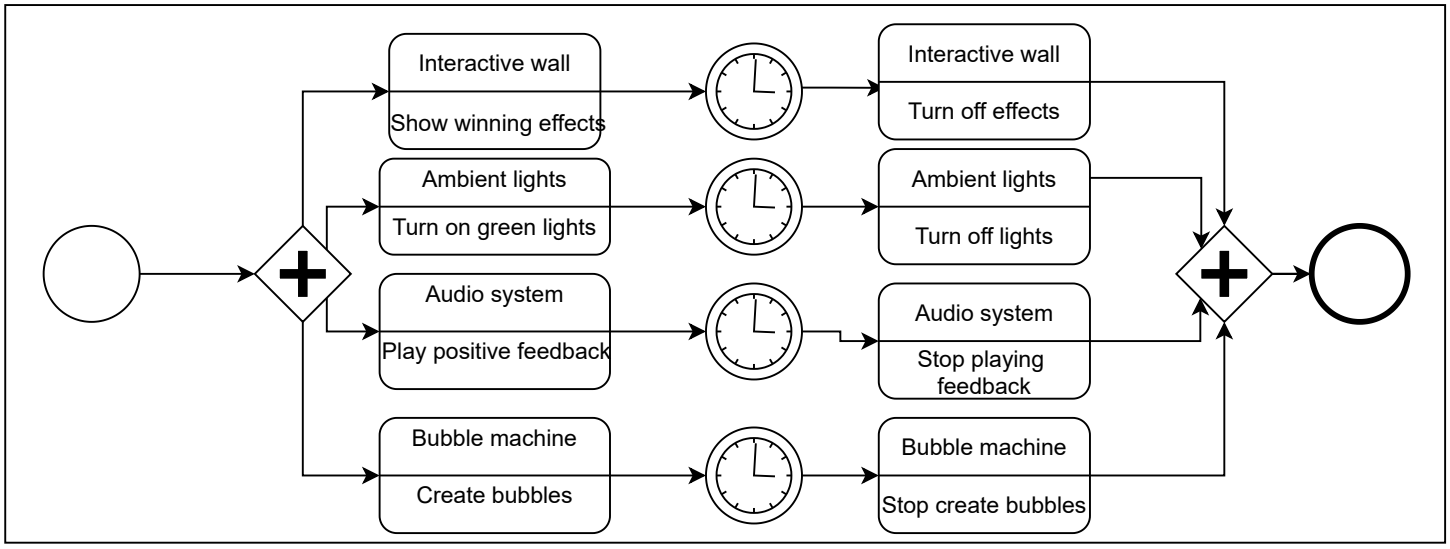
In this activity the children will learn how to recognize the species of some birds by their aspect, then they will learn some information about the behavior of the recognized birds.
At the beginning Emi explains briefly the activity and asks for a volunteer to stand up in the middle of the magic room. Then the interactive wall shows a forest background and a different type of bird flying in the environment. Moreover some clues are projected on the interactive wall so that the volunteer can guess the specie of bird to catch. The game is divided into 6 rounds, each round is dedicated to a specific bird projected in the scene. The volunteer can walk on the suggestions boxes projected on the wall in order to read some information about the bird to catch in the current round. There is also a special clue that will reproduce the sound of the bird.
So, the volunteer takes a choice and selects the chosen bird by pointing at it and acting the grasp gesture. If the answer is correct the Magic Room turns green, the caught birds is highlighted with a particles effect , a sound of victory is played. Otherwise, if the answer is not correct the MR turns red and Emi encourages the student to try again.
When the child has caught all the six birds, he reaches the end of the game, Emi congratulates with them and they can go back to the Museum.

Activity diagram

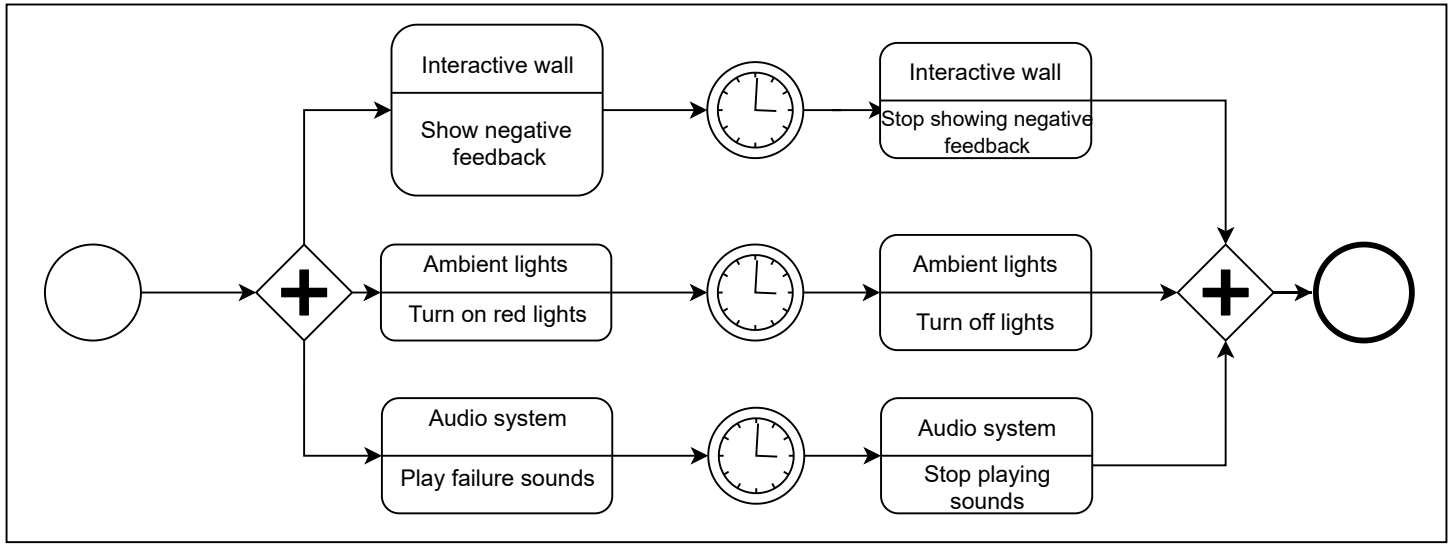


Effects

Interactive wall, ambient lights, audio system, bubble machine
Positive feedback



Interactive wall, audio system, smart lights
Negative feedback



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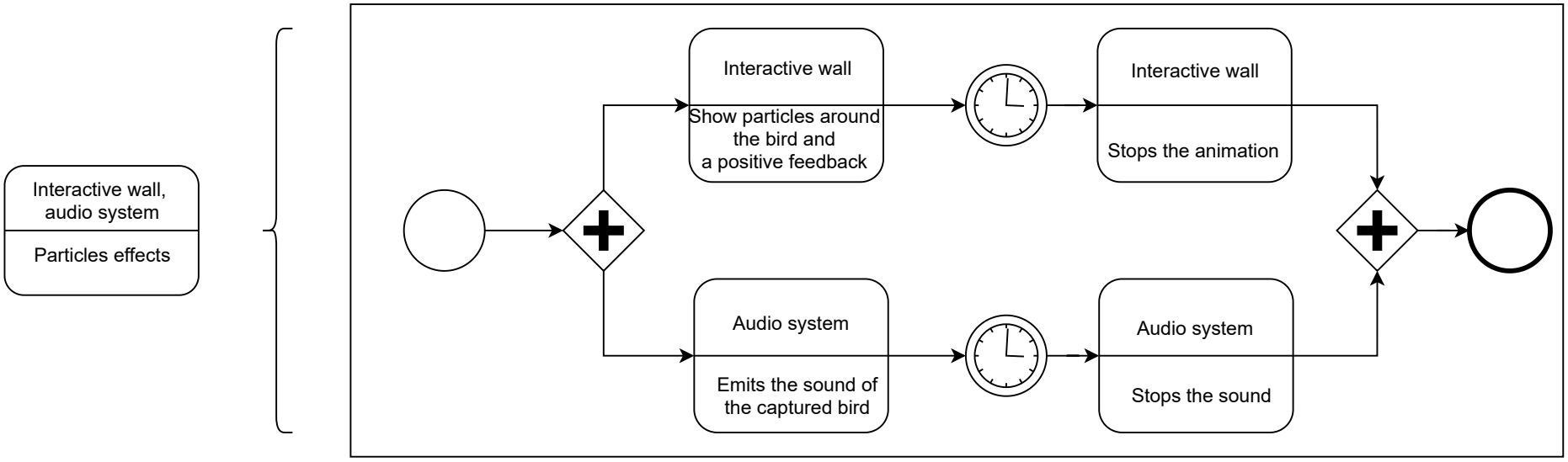
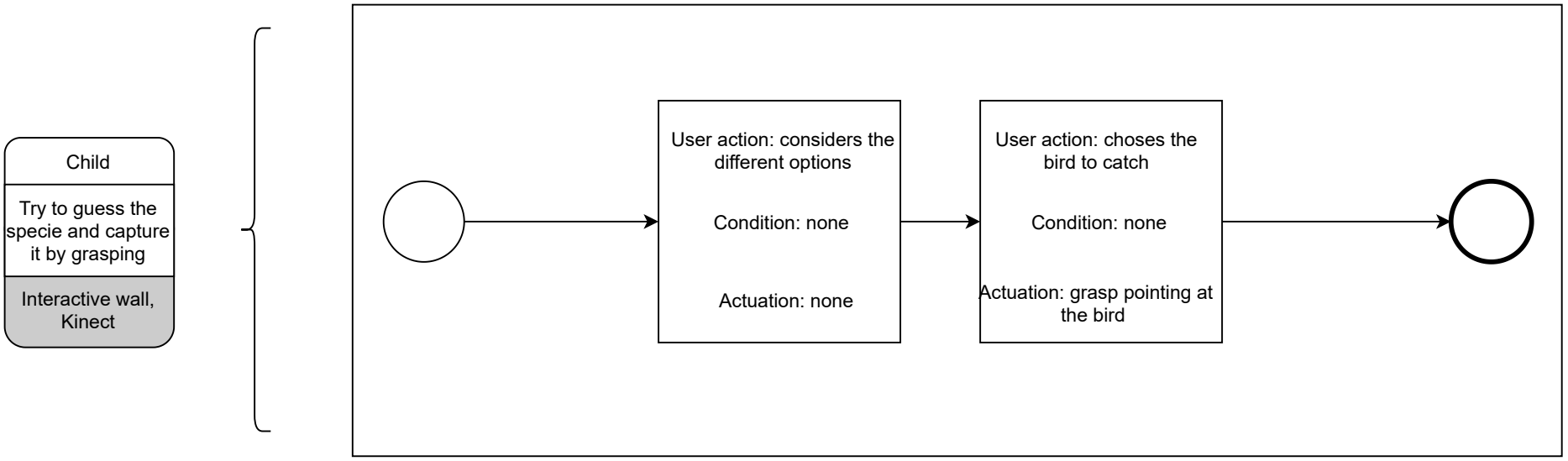


User Tasks



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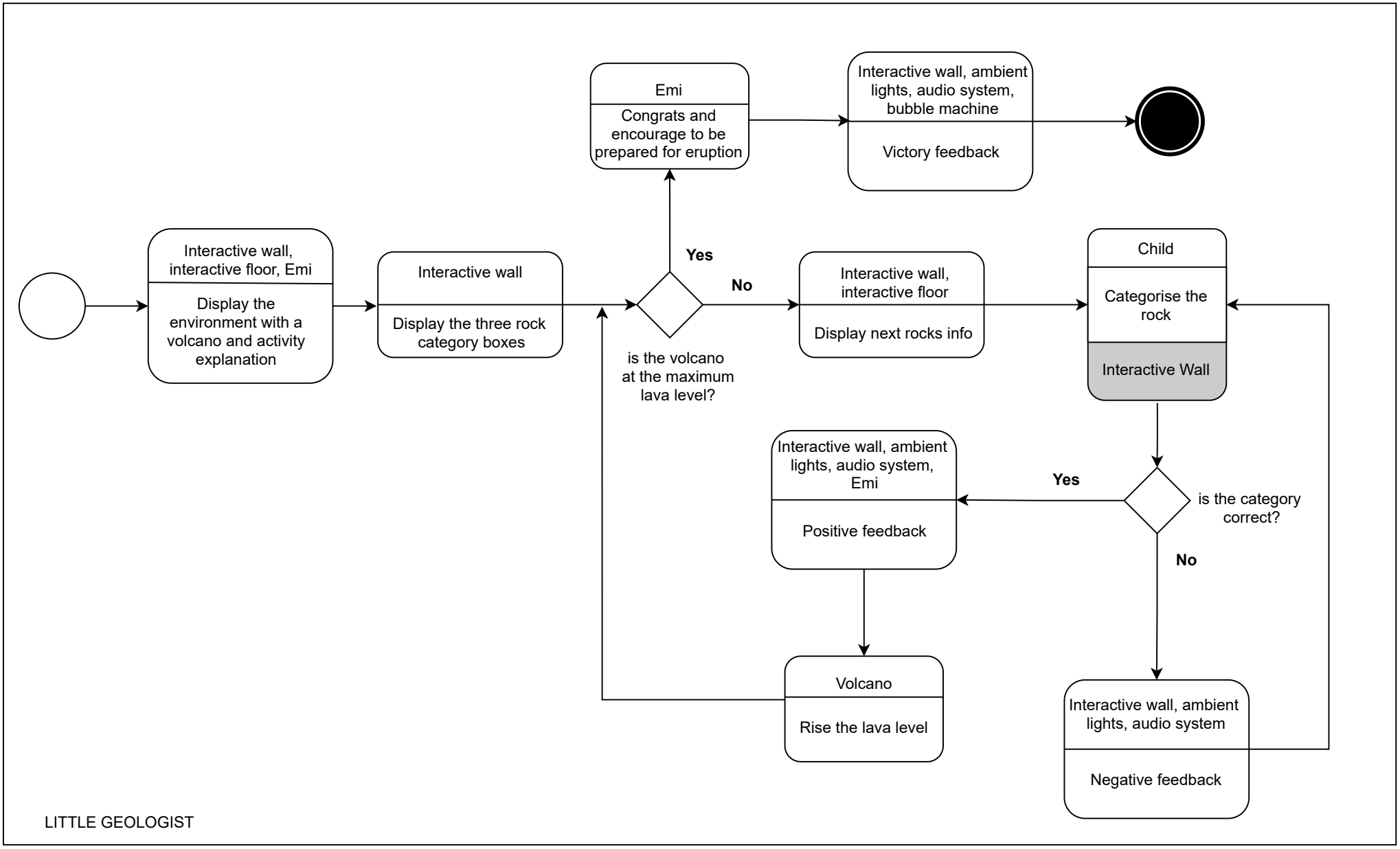
4.3.4 ISS Behavioural - Little Geologist

This activity is a categorization game where children are tested on their knowledge about rocks and their origins. The activity begins with Emi explanation about how to play the game: in order to make the volano erupts, each students has to give the correct answer.
The teacher asks for a volunteer to stand up in the middle of the interactive floor. A rock and three containers are displayed on the wall. The three containers correspond to three categories of rocks: igneous, metamorphic and sedimentary. The students is then have to categorize the rock. A visual representation of the rock texture and the rock name are displayed on the interactive floor, where an environment flooded with lava is shown. The categorization takes place with a grasp movement to select the virtual rock on the screen and a drag&drop movement in the container chosen.
If the rock is correctly categorized the room turns green, a greeting music is played, the rock disappear in the container and the volcano raises its lava level. If the choice is incorrect the room turns red, a failure sound is played and an animation on the wall shows the container that refuses the rock with a shaking effect.
Then an other student can try with an other rock. When the lava reaches it maximum level Emi encourages the children to be prepared for the eruption. The scene now changes and the volcano erupts with an animation showing the eruption on the front wall.

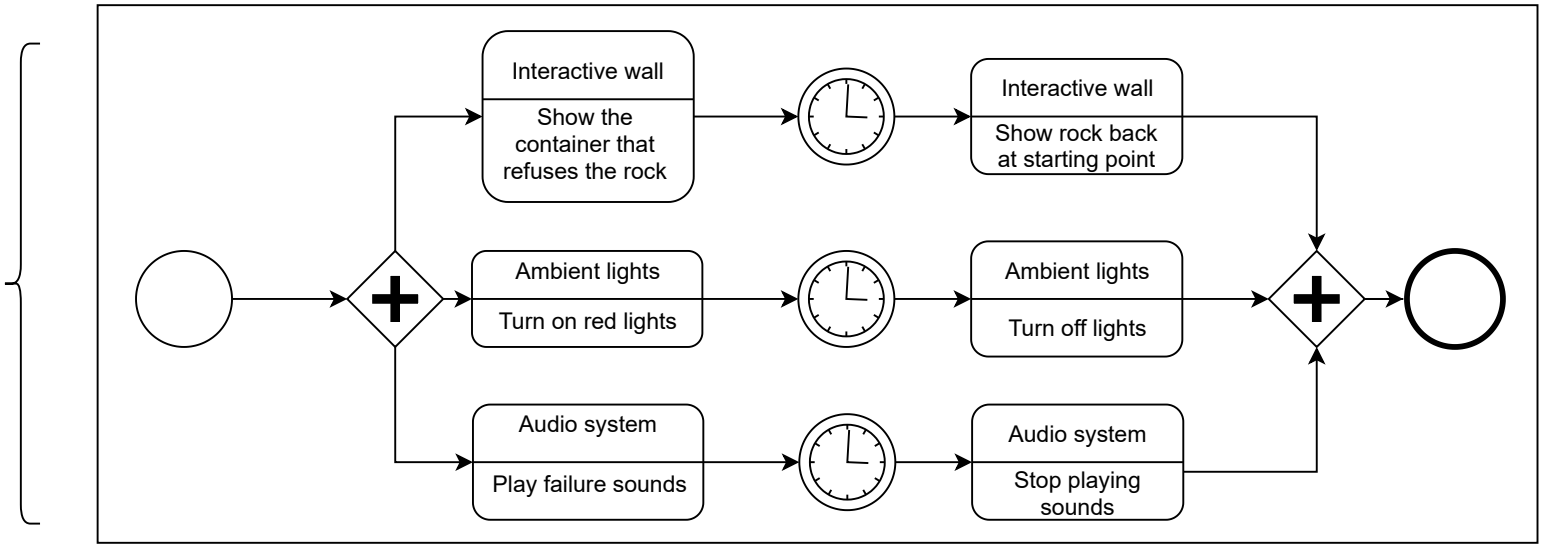
Activity diagram



Effects

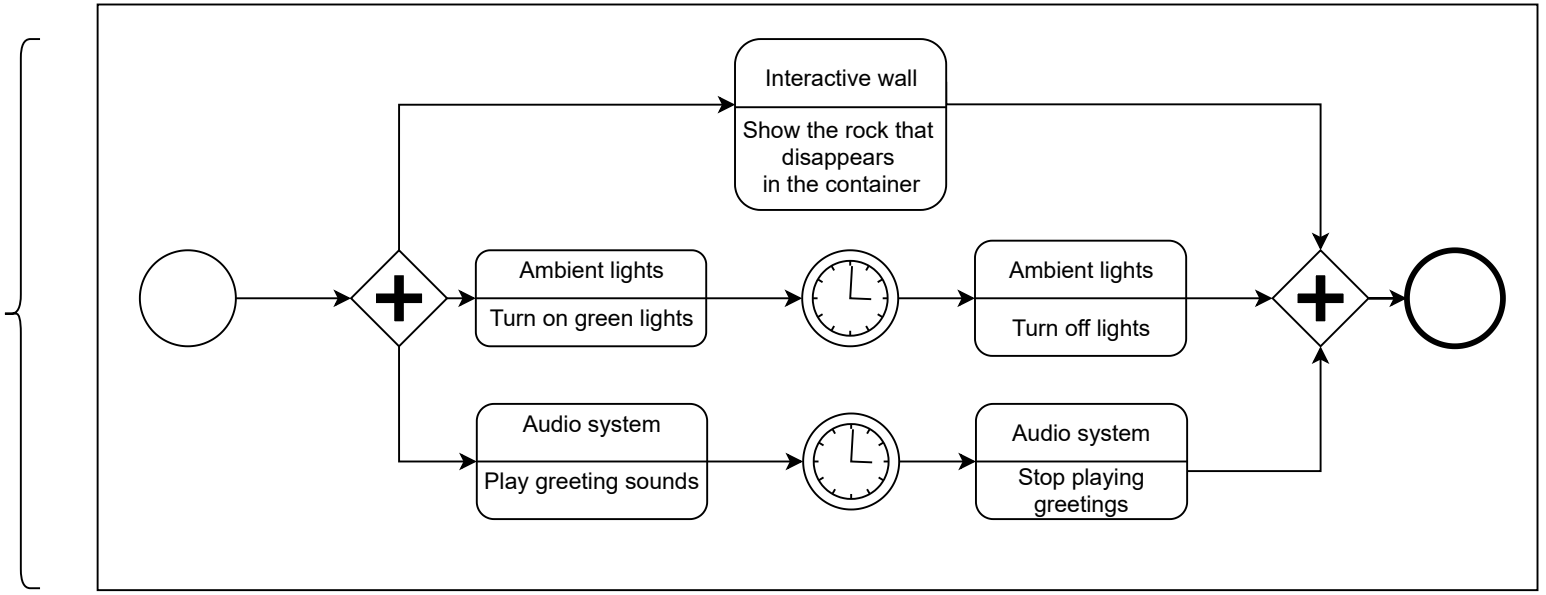
Interactive wall, ambient lights, audio system

Negative feedback



Interactive wall, ambient lights, audio system

Positive feedback



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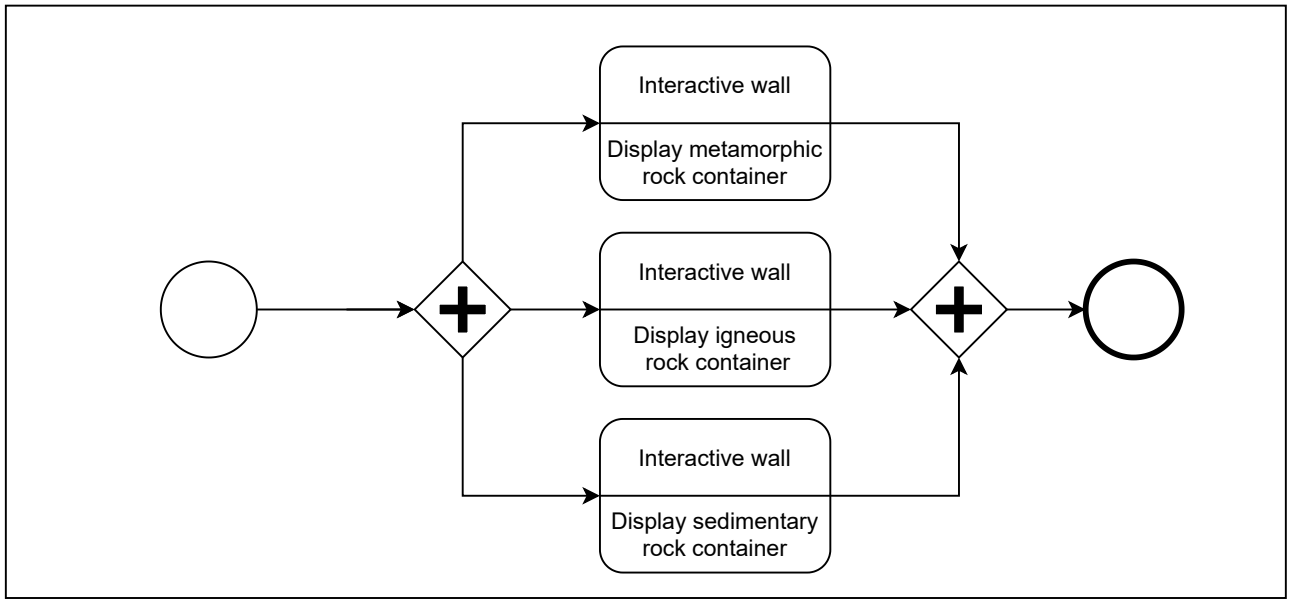
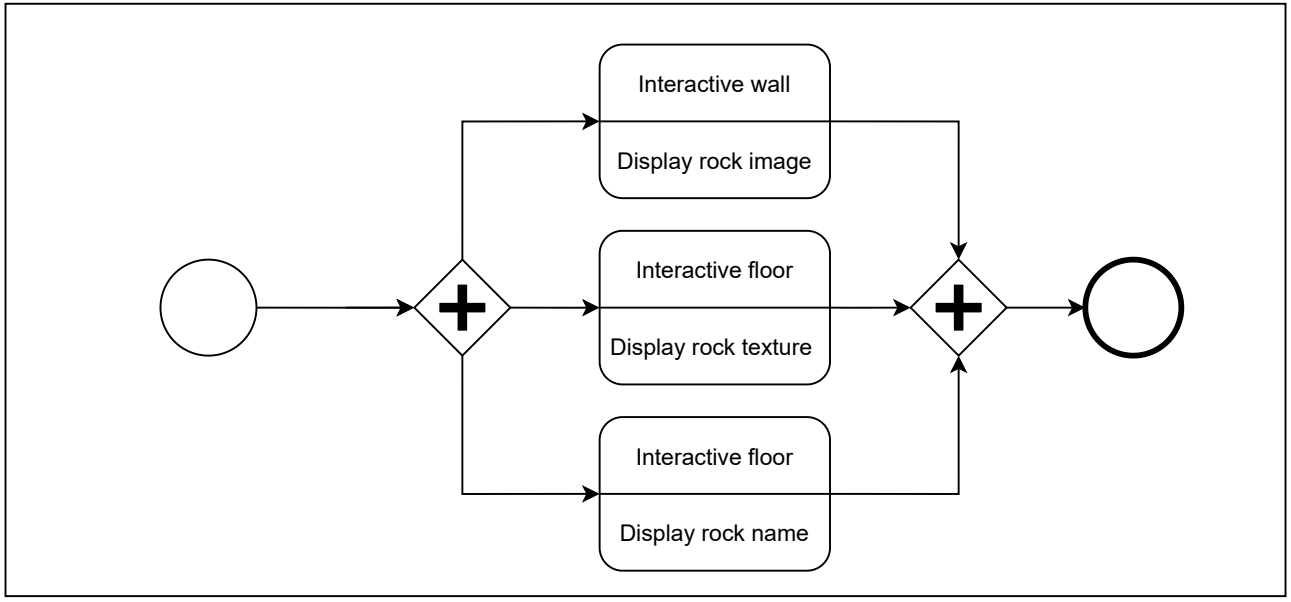
Interactive wall

Display the three rock category boxes



Interactive wall, Interactive floor

Display next rocks info



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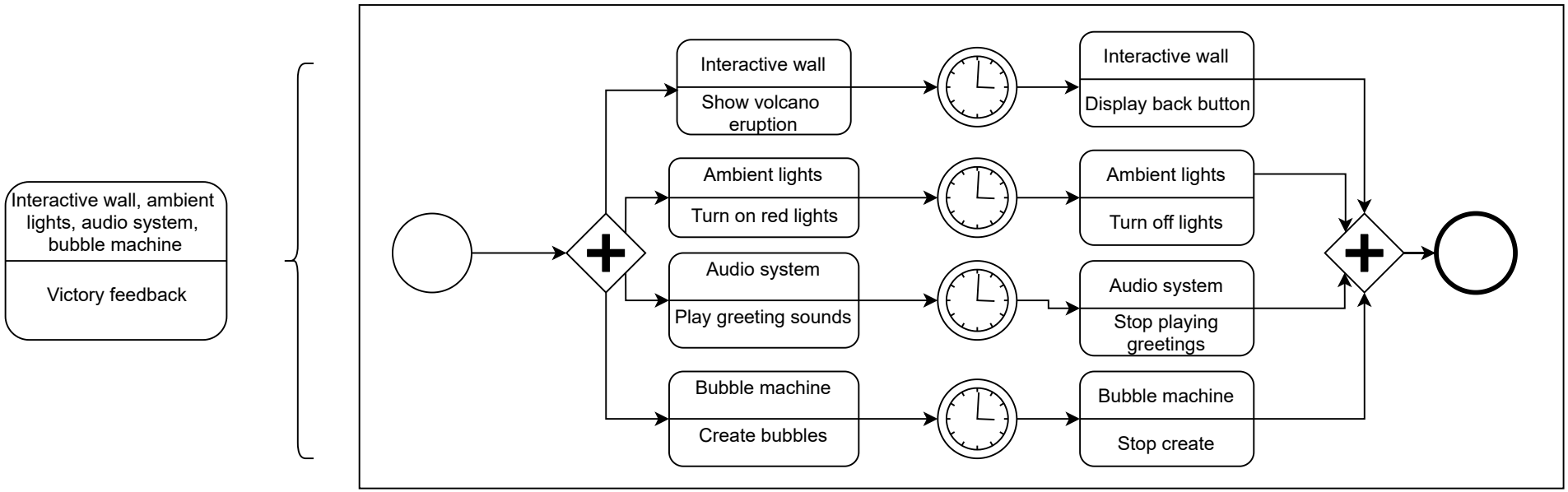
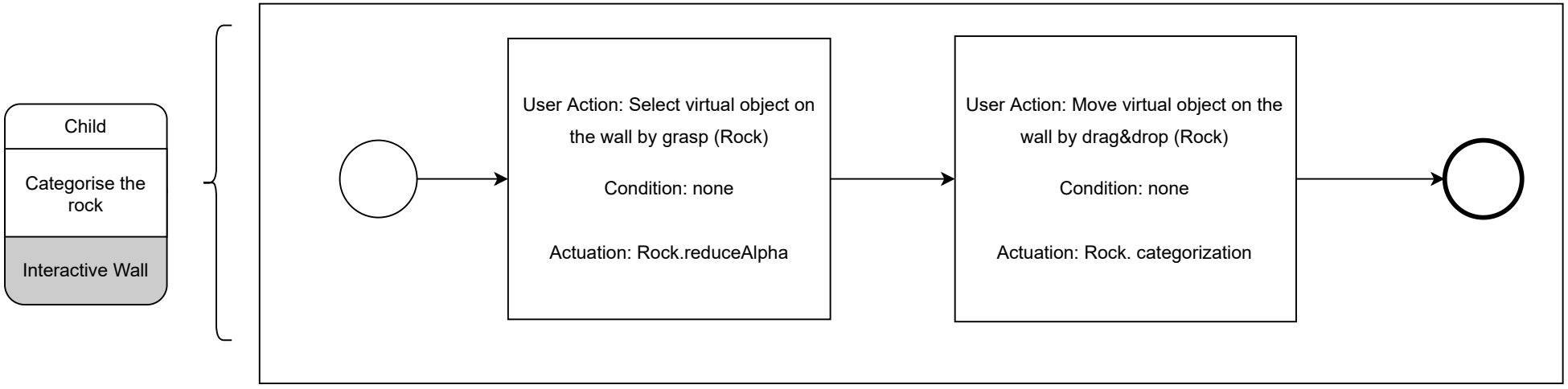


User Tasks



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5. Scenarios

Scenario 1

User Profile(s)

Elena, a 30 y.o. teacher in Pistoia

Goals(s)

is a new science teacher in the local elementary school. She has seen that there is a MR into there and decided to try this experience after that she taught some topics about the biosphere to here 4th year class to better understand how the children have learnt this part. Talking to the other teachers, Elena decided to “stole” 2 hours to the Math lesson in order to bring her students to the MR on Wednesday, in that day she already had 3 hours in the morning. Doing this, she has 5 hours to stay at the MR.

Context

On Wednesday morning she went to her 4th year classroom and leaded the children to the MR.

Task

Once there, she turned on the MR and asked for a child to be the navigator inside the museum. Giulia asked for doing that and Elena allowed her. The class decided to do the “matching the habitat” game and she watched how the children were answering and, after this mini-game, decided to plan a new lecture on habitats and ecosystem since some children were not able to correctly match animals and habitat cards.

Scenario 2

User Profile(s)

Giuliano, a 42 y.o. teacher in Palermo

Goals(s)

teaches at the fourth year in the local elementary school. Everyday he has to deal with children between 8 and 9 years old. Recently he gave a lecture about geology and the origins of rock during science class.
According to this, Giuliano wants to test how much attention the students put on the geology lesson so he decides to bring the class in the Magic Room for a quick visit just to asses their knowledge about that topic.

Context

The teacher makes a surprise to the students bringing them in the MR on Saturday morning.

Task

Once there, he turned on the MR and asked for a child to be the navigator. Giuliano asked to Gaia, the volunteer student for the role of the navigator inside the museum, to go to the Fossil Hall. Once there the Gaia interacts with the star on the floor to enter the Little Geologist mini-game. Playing the game, Giuliano was able to put a plus or a minus in the mark of each student according to the correctness of their answers.

Scenario 3

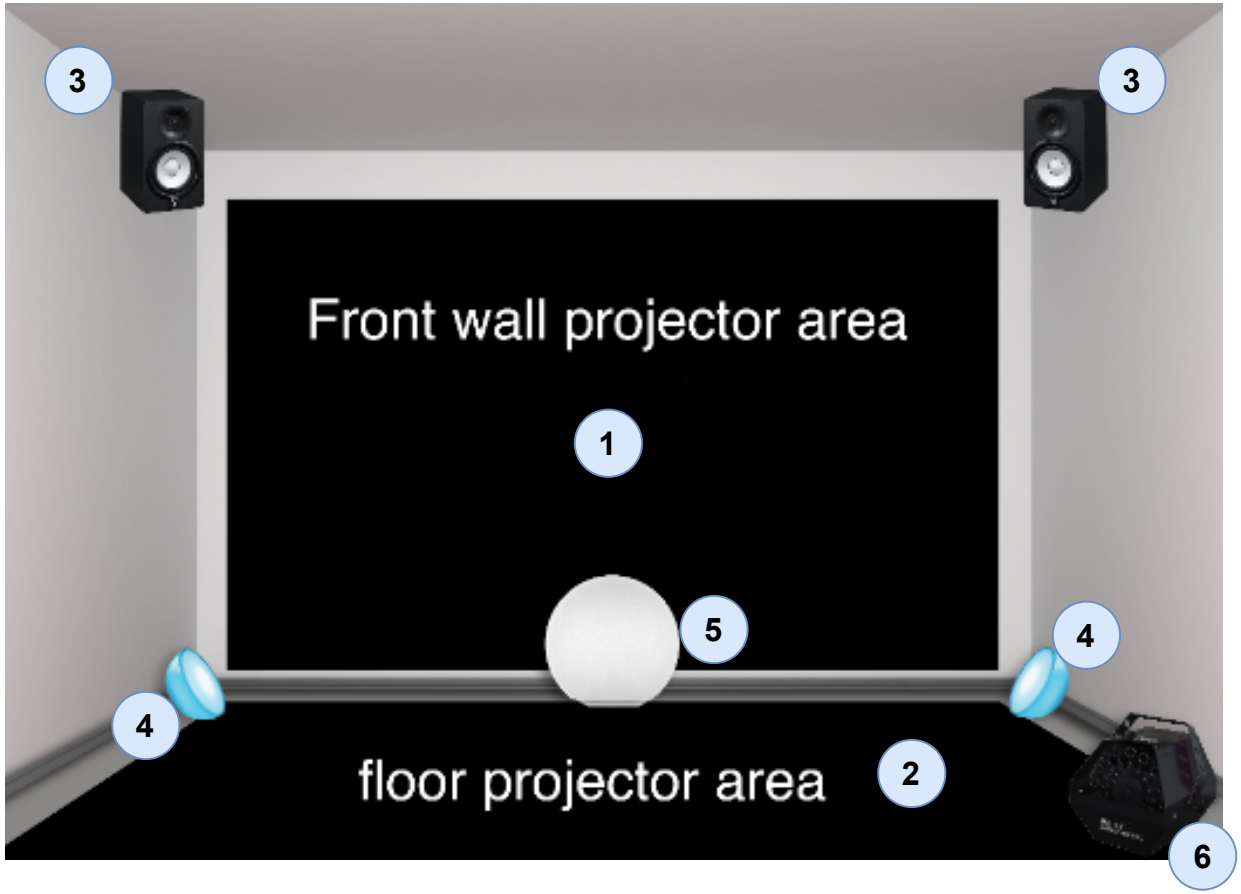
User Profile(s)	Alessandro a 6 y.o. student from a school in Lecce
Goals(s)	that has the MR installed in his school. He wants to know more about bird species and doesn't want to sit down all the morning, he needs to be active and to learn while having fun with his schoolmates.
Context	Alessandro persuades the teacher of science to bring the whole class to the MR and play a game together.
Task	Alessandro stands at the centre of the MR and he is amazed because It seems like he has been teleported in a real forest with tons of different trees and wonderful birds of every color and shape. He is very excited because he has to guess the right bird to catch using just some clues projected on the floor that he can interact with, so he is forced to take advantage of the topics studied in class reinterpreting them in a "real" environment. At the end of the game every bird has been correctly caught and all the students are satisfied because they have all been part of the exciting "haunt".

6. Implementation

Hardware

The necessary hardware is that related to the MR. In our activity we used often: Front and floor projectors, kinect, cards equipped with RFID, RFID reader (Magic Sphere), Bubble Machine, Smart Lights

1. Front wall projector area
2. Floor projector area
3. Audio System
4. Smart lights (also smart bulbs are disposed on the root)
5. Smart sphere (RFID reader)
6. Bubble Machine



Software

The software component relies almost completely on Unity and its supported programminglanguage C#. For this reason, the software architecture is related to the one provided by Unity and especially by its physics management. Here we summarize the mainconcepts used to implement this project.

- Scenes. Every scene contains a set of virtual Objects that can interact between them during the “Play mode”: the mode provided byUnity in which the user is actually capable to interact with the system.
- Component attachment to Objects. Each virtual object of the environment can have attached one or more components. Among these components we have often used:
    - Scripts, written in C# programming language
    - Canvas, to manage 2D pictures into it
    - Collider, to exploit the management of the powerful physics processing provided by Unity
    - Animator, to animate the scenes presented to the final user and make the interaction more enjoyable
- Start() and Update(). These are the two C# core functions supported by Unity. The first is invoked whenever the object to which the script is attached is enabled and the relative scene is started.
- Collisions. These are the components through which is possible to manage the physics into the Unity framework. Each collision happens between one or more Collider components. The Waypoints described on the previois sections, are implemented basing on this typology of components.
- Triggers. They are an extension of the collisions in the sense that triggers are just colliders that physically manifest themselves in a non-interruptive way during the collision. Thus, when an object collides with the trigger, the system is capable to know it, but the object will not interrupt its movement. These have been used, for example, to implement buttons on the UI.

Another important feature to mention inside our code, is the developed saving system, used to store the player position in a binary file. This is to avoid restarting the scene when, after playing a mini game, the player want to keep exploring the museum scene. BinaryFormatter and FileStream C# object are used to achieve this goal, storing Serializable part of the data regarding the Player. In this case, a PlayerType class is attached to the Player object in unity and refers to its position (transform) and the waypoint currently colliding with in the Museum Scene.

7. Value Proposition

Everyone in our team was not familiar with the technology used in the MR and we were not very expert in the use of the ISS model in order to model the experiences that we wanted to provide. Moreover we had never used Unity before this project and to make matters worse none of us had a real background in UX design. Therefor this project was very challenging for us at almost every point of its development.

We needed to spend some time in learning the functionalities of Unity in general and we were "forced" to use only free assets available in the Unity Asset Store so we were not completely free in the customization of the museum and of the mini-games, though we are very satisfied from the final results.

We also found some difficulties in sharing the contents of the unity project on GitHub and this was quite a huge problem due to the fact that we weren't able to meet in person because of the COVID-19 pandemic.

However, to our mind, we managed in creating a wonderful experience for our main stakeholders namely elementary school teachers and children from 6 to 10 years.

Our product is the perfect solution for every elementary school teacher that wants to provide educational contents to their students and at the same time making children develop collateral competences and soft skills related to the cooperation with schoolmates in order to achieve a shared objective. Our experience makes children learn a lot of things about different topics on the natural history in general, makes them appreciate more the process of learning and moreover gives them the chance of developing strong relationships with their schoolmates and with the teachers themselves. After the teacher has gained the trust and the attention of the students, also the traditional activities in the classroom are seen in a totally different way from every child, so the students will be much more open to the process of learning because this process will be seen as something essential in order to have the chance of participating to new exciting and fun activities in the MR.

Looking at the state of the art of this research area, we can firmly state that our product is the best possible solution for our stakeholders because even if there are some existent museums that provide a virtual tour, none of them is built with the purpose of offering a multisensory experience to children. Therefor if your objective is building a new way of communication with your students and offering an innovative chance of rehabilitation for children with NDD, MuseX is the only possible choice.

As main competitors of MuseX, we identified all the virtual Museum tours identified in the State of the Art Section and Moreover, we had VR interactive experiences to target all the goal not directly linked to exploring a Museum but more on the interactions point of view. A technology such as visors can be considered to offer a good immersive and interactive experience but, in our opinion, a iMSE such as the Magic Room has unique feature that cannot be replace by VR only.

8. Future Work

Our work is ready to be used and It exploits all the different activities that can be done inside the Virtual Museum, however we have tons of ideas that can be easily implemented in the future and that can enrich the experience inside the Museum. Other things are more difficult to be implemented and require a significant amount of time, but everything that is presented in this chapter is concrete, feasible and clearly documented.

Short Term

Here we have everything that could be easily implemented, indicatively it would require a couple of months. In particular we have designed 3 more mini-games to enrich the experience of the children inside the Museum, but we have also thought of a new experience during the visit of the halls of the museum. Eventually we would also be able of connecting our software to the physical devices of the MR.

1- Feeding the animals - food chain recognition

This game has the aim to verify the learning and to stimulate the interests of the children about the feeding of the animals and the food chain related to it. Before of this activity there has to been distributed the plastic feedings into the room (such as plastic steak, or plastic broccoli). This task can be accomplished by the teacher at the very beginning of the activity or by someone else (such as the MR staff) before of the MR Museum activity. At the beginning of the activity Emi asks for two leaders, at the same time two blue circles appear in the floor in front of the wall: at this point the teacher have to split the class into two teams. The teams have the time to discuss who will be the leader and when they have decided the two designed leader have to stand on the blue circle and wave their hand.At the beginning of the activity Emi asks for two leaders, at the same time two blue circles appear in the floor in front of the wall: at this point the teacher have to split the class into two teams. The teams have the time to discuss who will be the leader and when they have decided the two designed leader have to stand on the blue circle and wave their hand.Now it can begin the real activity of the mini-game. The front screen is splitted into two sections each dedicated to a single team.On the top of the screen it appears a timer, after that timer the team with more point will win the mini-game.The teams can gain one point for each guessed animal. Indeed, it is assigned a different animal for each team projected in the wall in front of the assigned team. The teams have to guess which food do the assigned animal eat by searching into the room the right feeding and booking the temporal spot to guess the feeding by waiving the hand of the leader. The team now has 5 seconds to scan the plastic food: when a food is scanned, it appears on the foreground of the front screen. In case of negative response the assigned animal goes to the foreground, smells the food, appears disgusted about it, and returns back to its spot in the background. In this case, the team have to repeat the procedure to guess. In the case of positive response, the animal comes to the foreground, smells the food and eats it. At this point in the front screen section dedicated to the team which guessed the feeding it appears a food chain pyramid: the leader, with the other children help, has to guess the position of the assigned animal in the pyramid. In case of wrong answer it is assigned a new animal but the team does not gain the point, in case of positive response the team gains the point.

2- Puzzle Game

This activity has the aim of training the logical skills of the children that play the game, and also making them aware of new animal species with their main characteristics. As a matter of fact, this activity is divided in two parts : in the first part two children play a puzzle game against each other in which they have to rebuild the skeleton or the shape of an animal, instead in the second part they have to guess the specie of the animal that is represented in the puzzle. In the first part the teacher choses the children that will play the game and Emi explains briefly the rules of the game, so the timer starts and the children stands in front of the interactive wall. Two animals broken into pieces are projected on the wall: one animal in front of each child. Each child has to rebuild the animal whose parts are projected in front of them using a drag & drop animation to place each piece of the animal in the right position. However the child won't know instantly if the piece of the puzzle they have just placed is in the right position so the game cannot be based on a trial and error technique. When one child completes the puzzle of their own animal the second part of the game can start. If no one manages to finish the entire puzzle before the timer of 3 minutes ends, the child that has placed more pieces correctly wins. On the wall 5 alternatives are projected , each of them contains the name of one specie of animal. The child that has completed the puzzle first starts this second part: he has two chances to guess the specie of the animal represented on the puzzle. If he can't answer correctly there will be 3 options remaining and the child that lost the first part of the game has one chance to guess the specie. If he neither is able to guess correctly the specie of the animal represented in the puzzle of the winner, the first child wins the game, the magic room displays the habitat of the animal. Now the animal plays some animations and emits some characteristic sounds. Then two other children can play the game with two different puzzles.

3- I believe I can fly - quiz edition

This activity has the aim of training the logical skills of the children that play the game, and also making them aware of new animal species with their main characteristics. As a matter of fact, this activity is divided in two parts : in the first part two children play a puzzle game against each other in which they have to rebuild the skeleton or the shape of an animal, instead in the second part they have to guess the specie of the animal that is represented in the puzzle.In the first part the teacher choses the children that will play the game and Emi explains briefly the rules of the game, so the timer starts and the children stands in front of the interactive wall. Two animals broken into pieces are projected on the wall: one animal in front of each child. Each child has to rebuild the animal whose parts are projected in front of them using a drag & drop animation to place each piece of the animal in the right position. However the child won't know instantly if the piece of the puzzle they have just placed is in the right position so the game cannot be based on a trial and error technique. When one child completes the puzzle of their own animal the second part of the game can start. If no one manages to finish the entire puzzle before the timer of 3 minutes ends, the child that has placed more pieces correctly wins. On the wall 5 alternatives are projected , each of them contains the name of one specie of animal. The child that has completed the puzzle first starts this second part: he has two chances to guess the specie of the animal represented on the puzzle. If he can't answer correctly there will be 3 options remaining and the child that lost the first part of the game has one chance to guess the specie. If he neither is able to guess correctly the specie of the animal represented in the puzzle of the winner, the first child wins the game, the magic room displays the habitat of the animal. Now the animal plays some animations and emits some characteristic sounds. Then two other children can play the game with two different puzzles.

In the short term we would also connect the Virtual Museum to the technology of the Magic Room. Since now we have used the provided simulator, however we would be excited to visit the MR in order to concretize the connection between our software and the available devices. Doing so we could adjust the mini-games and the whole museum to the real final effect on the MR, adding and changing some feedbacks in order to become more effective for the children

We have also designed another experience to be performed during the visit of the halls of the museum that is related to the topic of feeding the animal. This are the main characteristics of the experience:

1- INVOLVING THE TEACHER: during the navigation, at a certain time, the teacher can activate an "unexpected event" for the child that is managing the navigation. Emi appears in the wall and announce that a big animal is escaped from their cage and is very hungry. The child has to choose between three different nourishment for the animal that are shown in the wall.
2- PHYSICAL ACTIVITY: The child should rapidly choose which is the right nourishment for the animal and before the timer ends, the child has to pick up the right tagged card representing the chosen nourishment and then the child should run to the RFID reader in order to scan the card.
3- FINAL FEEDBACK: If the child was correct in choosing the nourishment, the animal will be calmed down and the child can continue on being the navigator on the museum. Otherwise if the child chose the wrong card, the animal "catches" the child so that they can no more be the navigator and another child will take their place. This fact can be used from the teacher in order to incentivize a rotation on the role of navigator during the visit of the museum, because instead of just saying to the navigator that they have to leave their role, the teacher can use this "unexpected event" in order to perform the rotation in a less traumatic way for the child.

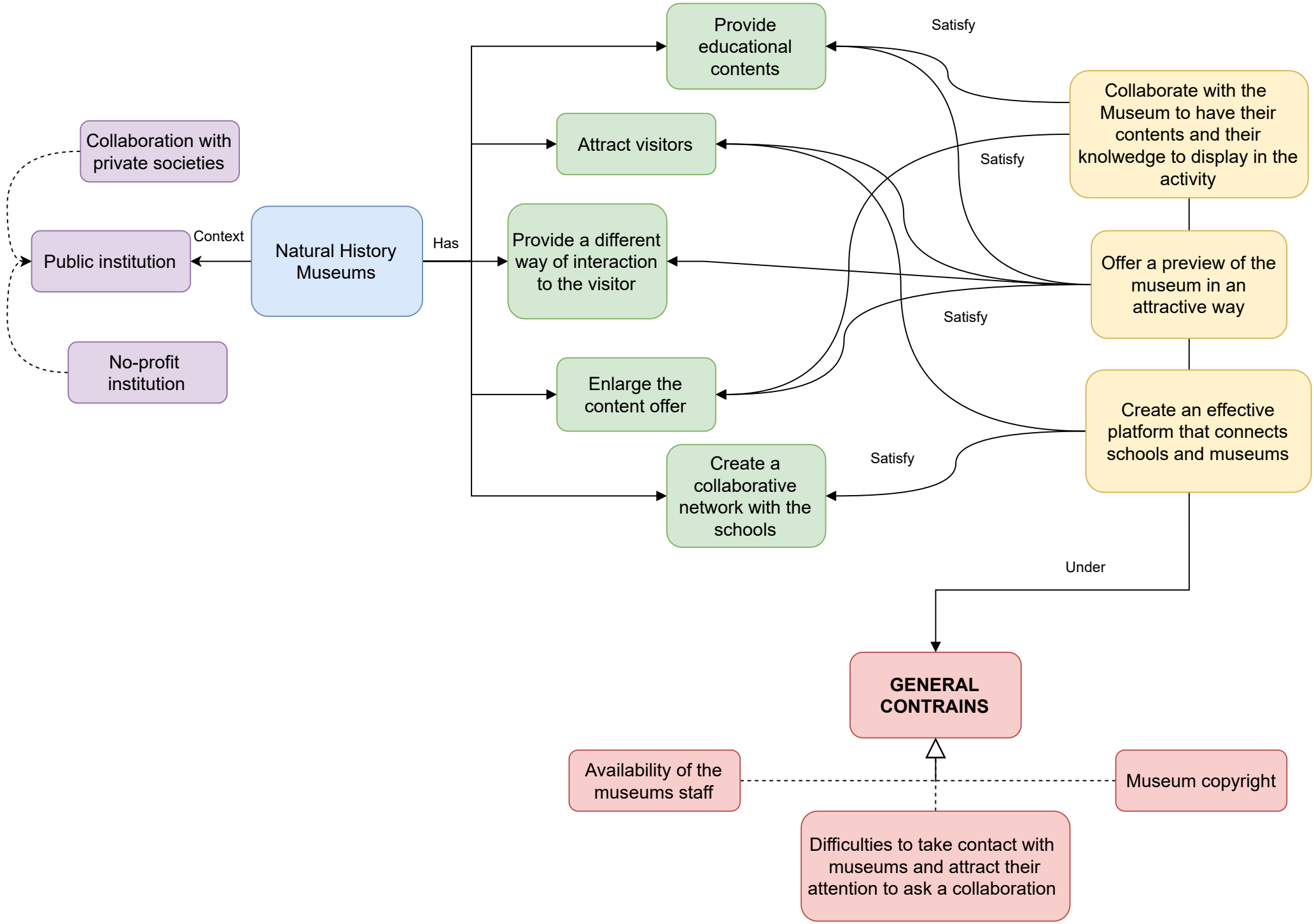
Medium Term
In the mid term we would like to enhance the experience in the Museum in some different ways that would require some more months. We are sure of being able to add this things if we are given the right time.

1- Designing and implementing brand new mini-games to add to the Virtual Museum, something that we should design from scratch exploiting the experience and the know-how that we have gained in this months of implementation.

2- Adding new ways of interaction between the children and the Museum and new ways of learning with fun: we are thinking of adding some special videos in which some theoretical contents are explained, in order to disengage the games from the real school lessons.
In our mind the experience should be complete in the sense that the children can watch inside the Museum an interesting video on a certain topic for example about birds animating some of the birds shown and then they can play the related mini-game named "Catch the big birds!". In this way the children can consolidate their knowledge about birds playing with their schoolmates and the teacher can assess their competences assigning them a positive or negative mark.

Long Term - Vision
In the long term view we would try to insert existent physical museums in the list of the stakeholders of our product. In fact we believe that every type of existent museum, also non related to the natural history, could be interested in such an experience. They could be interested not only in the virtual representation of their museum but especially in the enrichment of the general experience offered. Having a MR installed inside the museum, they could provide the visitors behind a certain age with some awesome interactions with the most important attractions. In this way they would enlarge the customer base also to those families with children who are in general not attracted by this type of visits.

Since a real museum can be considered as a new stakeholder for our project, we designed also a UNG diagram with a focus on this new stakeholder.


Collaboration with private societies
Public institution
Context
Natural History Museums
No-profit institution
Has
Provide educational contents
Attract visitors
Provide a different way of interaction to the visitor
Enlarge the content offer
Create a collaborative network with the schools
Satisfy
Satisfy
Satisfy
Satisfy
Collaborate with the Museum to have their contents and their knolwedge to display in the activity
Offer a preview of the museum in an attractive way
Create an effective platform that connects schools and museums
Under
GENERAL CONTRAINS
Availability of the museums staff
Museum copyright
Difficulties to take contact with museums and attract their attention to ask a collaboration

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