AP HOGESCHOOL ANTWERPEN

AP.BE

Inclusive Playtime

Project report

Education: European Project Semester

Academic year: 2021-2022

Formatted on: 16th of June 2022, Antwerp

Clients: Filip Gerits – KBT

Kathleen Op De Beeck

Authors:

Project leader: Indra Liekens - indra.liekens@student.ap.be, +32 489 40 17 21

Project members:

Lindsay Van Damme - lindsay.vandamme@student.ap.be, +32 477 08 50 57

Mateusz Włodarczyk - mateusz.wlodarczyk@student.ap.be +48 694 71 00 28

Alicia Garcia - alicia.garciarosa@student.ap.be, +34 634 15 62 36

Andres Davalos - s099352@ap.be, +32 456 20 79 31

Muhammetali Sevindik - muhammetali.sevindik@student.ap.be, +32 465 23 54 45

Gamze Sarikaya - gamze.sarikaya@student.ap.be, +49 174 31 76 135

Preface

This report is written for the professionals and (future-) students who will participate in this project, *Inclusive Playtime*. In this we will give the reader a view on the process of the project and how we see our concept in the future.

The authors of this report are seven European students, all from different fields of education. The different fields in our team are: ICT, Mechanical engineering, Industrial design engineering and product development, Graphic and Digital Media, Occupational therapy, International finances and Early childhood education. As you can see, we have very diverse backgrounds. This made it educational but also challenging to work together.

We are grateful that our clients, Filip and Kathleen, gave us the opportunity to work on this project. They started this project due to a gap in the market since there are not enough inclusive playgrounds that are challenging as well. Hilde Van Himbeeck, lector in social works, and Erwin Listhaeghe, lector in Graphic and Digital Media, coached us through the whole process.

We want to thank everyone who was involved in this project. In the first place our clients who made it possible to work on this project. We also want to thank our coaches who always supported us when we had struggles. Besides, a word of thanks to the teachers from the other courses who also taught us a lot. Finally, a big thank you to all the professionals, schools, and organizations… whose expertise was essential to realizing this project.

June 2022

Indra Liekens
Lindsay Van Damme
Mateusz Włodarczyk
Alicia Garcia
Andres Davalos
Muhammetali Sevindik
Gamze Sarikaya

Table of contents

Inclusive Playtime 1
Project report 1
Preface 1
Table of contents 3
Summary 8
Introduction 9
Project Process 10
1 History of the project 10
2 Steps 10
2.1 Introduction 10
2.2 Research 10
2.3 Concepts and requirements 12
2.3.1 Individual brainstorm 12
2.3.2 Group brainstorm 12
2.3.3 Brainstorm with Filip (client) 12
2.4 Research concept 13
2.4.1 Disabilities 13
2.4.2 Design 13
2.4.3 Electronics 14
2.4.4 Game value 14
2.4.5 Materials 14
2.5 Design concept 14
2.5.1 Prototype 14
2.5.2 Concept 15

2.6 Create 15
2.7 User testing 16
2.7.1 REVA-beurs (Ghent) 16
2.7.2 Ritmica 16
2.7.3 Heder 17
3 Deliverables 17
3.1 Prototype 17
3.2 Market and financial analysis 17
3.3 Product and design concept 18
3.4 Proof of concept 18
3.5 Design logbook 18
3.6 Presentation 18
4 Monitoring 18
4.1 Rules 19
4.2 Roles 19
4.3 Tools 19
4.3.1 OneDrive/Teams 19
4.3.2 Notion 20
4.3.3 Todoist 20
4.3.4 WhatsApp 20
5 Contributors 21
5.1 Supportive courses 21
5.1.1 Entrepreneurship and corporate communication 21
5.1.2 English language and presentation skills 21
5.1.3 Cross-cultural exploration 22

5.2 Stakeholders....22
5.2.1 Clients....22
5.2.2 Coaches....23
5.2.3 Project team....23
5.2.4 Children and their parents....23
5.2.5 Makerspace....24
5.2.6 Schools and other organizations....24
6 Strengths and challenges....24
6.1 Strengths....24
6.2 Challenges....24
Project Results....26
Conclusions and Recommendations....28
8 Conclusions....28
9 fails during the project....28
9.1 Arduino....28
9.2 Nets....29
9.3 Soldering....29
9.4 Multiplexer....30
9.5 PCB....30
9.6 Code....30
10 Improvements....31
10.1 Improvements prototype....31
10.1.1 Hardware....31
10.1.2 Code....32
10.1.3 Design....32

10.2 Improvements concept 32
10.2.1 Floor 32
10.2.2 Table 33
10.2.3 Games/Interactions 34
10.2.4 In- and output 35
List of References 36
Appendices 37
11 Overview 37
12 Electronics 39

Summary

This report aims to inform everyone involved in this project. We worked on the project “inclusive playtime” that was started by two clients: Filip of KBT and Leen Op De Beeck. KBT is a factory that produces component for playgrounds. Kathleen Op De Beeck is an occupational therapist and teacher at AP University. We had to design a component for a playground that had to be inclusive, interactive, tangible and electronic. We also had to make a prototype of this component. The target group were children between three and eight years old. We want to give the reader an insight into the context, the process, and the results. Besides, we wrote down how we see this project in the future in the conclusions and recommendations. This to help the people who will be working on this project after us.

The project took place from February 2022 until June 2022. During this period of time, we used the ‘waterfall’ methodology. This means we made sure that every step was worked out 100% before going to the next one.

After testing the prototype, we can conclude that most of the children like the concept. They like the lights and the sounds. For some children, especially children with ASD (Autism Spectrum Disorder), it is necessary to implement games with rules. Overall, the professionals see the potential of the concept.

Due to lack of time and money we were not able to make it exactly like we want. The concept still needs a lot of improvements. We recommend the next group: to focus even more on the inclusivity of the component. Open-ended and ended pay is recommended as well.

Introduction

This project was started due to a gap in the market. When you look at current playgrounds, they mostly are not inclusive. If they are inclusive, they are often not challenging or interactive anymore.

In the convention on the rights of the child[1] (article 31), you can read that it is a right for children to play. Even children with disabilities should be able to go to a playground and play there. To ensure that every child can play, it is necessary to make an accessible and adjustable toy. Since social contacts are crucial for children to develop their skills, it is really important that they can play together with other children of their age.

We solved this problem by making an inclusive play component. We designed a led floor and led table with different kinds of interactions and games that all children can enjoy. The component is adapted so even children in a wheelchair, children who are blind or deaf or children with a mental disorder can have a great time.

[1] *OHCHR, 1989.*

Project Process

1 History of the project

We're continuing the work of the previous project team. Last year, they did a lot of research and worked out another concept. They made a vibration plate for which patterns were made according to the frequency. Their concept had a lot of good things we used, like the action-reaction and the design.

2 Steps

To succeed in this project, we had to make a clear overview of what we wanted to do when and what steps we had to take. In the Project Plan we worked this out in detail. Our client gave us advice on how long every step should take and which steps needed more time. The waterfall methodology showed us that it was very important to finish one step before starting the next one.

2.1 Introduction

In the first phase of the project, we wanted to get to know each other better. During the first week, we took time for this. We also had to make a project proposal and a project plan. We had to present the project proposal to the other students, the coaches and the client. We presented our team, what our strengths and challenges are and why we are the perfect team for this project. Additionally, we divided the roles in our team and made rules. In the project plan we had to make an overview of the project. Who would do what? And how would we do it? This really helped us to get on the same page. After this, we got a "go" from our client and we could really start with the project.

2.2 Research

We took our time to get to know everything we needed for the project. Overall, this phase lasted five to six weeks. To start, we dived into the research that was given by our client and the previous project group. This was necessary to get to know our target group. Most of us did not have experience with disabilities. Since the

component must be inclusive it was really important to learn more about disabilities and the topic of inclusion.
We read a lot of articles, browsed the internet, watched TedTalks, watched YouTube videos. This part of research already taught us a lot about physical and mental disabilities but having a real-life experience was the most effective way to gain more knowledge.

Firstly, we went to *Ritmica*, a school for children with special needs. We could observe children with helping aids, like a wheelchair or a Kaye walker. There were also some children with mental disorders, for example autism. We could ask the children, teachers and therapist questions about playgrounds and playing in general. This was very useful to get to know what children like and what the challenges or difficulties are when we are creating an inclusive play component.

Secondly, a few people from our group went to *De Kangoeroebeurs*. This is a fair for children with disabilities and their parents. We were able to ask a few questions to some parents and schools. It was also really educational to see different kinds of children with all different disabilities. This fair was a real eye-opener for some of us.

Finally, we had a guest speaker coming over. Beno Schraepen is an orthopedagogue and a lector at AP. He gave us a lecture about inclusivity. Our understanding and knowledge about inclusivity were broadened greatly.

Furthermore, we did research on similar products that already exist. There are some companies that are already building inclusive playgrounds. We watched videos and browsed their sites to get some inspiration and gain knowledge. Safety is also very important, which is why we also did some research about the safety requirements at inclusive playgrounds.

After this step, we were aware of what we should keep in mind and what we should avoid when we would start brainstorming.

2.3 Concepts and requirements

In this phase, we had to brainstorm a lot. In these two weeks we wanted to gain as many ideas as possible. It was important that we thought out of the box and without limitations. We started with an individual brainstorm, then we had one with our group and before making the decision, we had a final brainstorm with Filip. Of course, it is really important that the concept follows all the requirements, so we brainstormed about these as well.

2.3.1 Individual brainstorm

To start, we all did an individual brainstorm. We wrote down all ideas we had, similar project we could find and the requirements.

2.3.2 Group brainstorm

After the individual brainstorm we presented all our ideas to each other. By showing the ideas we gained new ideas. We made a list of all the things we had in our mind and voted for the most popular ones.

2.3.3 Brainstorm with Filip (client)

We started this day in the neighbourhood of the school and went exploring. We looked for formal and informal playgrounds[2]. We also did some brainstorm exercises. In the afternoon, we thought about more ideas in two teams. Every team chose their three favourite ideas and we compared them to the requirements. After the comparison, already two ideas did not comply.
We vote for the last four ideas and we finally had a winner. The idea that became our concept was: an interactive floor!

[2] Formal: playgrounds: components like slides, swings… that are meant to play with.
Informal: things that were not made to play with but that can be used as a play component like poles, ramps, benches…

2.4 Research concept

Of course we had to do more research about the concept that we picked. What games/interactions can we implement? What are the possibilities for the design? How can we make it as inclusive and adapted as possible. We had a look at similar ideas to inspire us. It took us two to three weeks to get to know more about the possibilities of this concept.

2.4.1 Disabilities

Soon, we found out that only the floor would not be inclusive enough. There are children who are sitting in a wheelchair for who a floor probably isn't something interesting. Therefore, we decided to implement a table to solve this problem. The table makes that there are more possibilities.
We did research about the measurements of different wheelchairs and other walking aids. This was necessary because we had to know how strong the floor should be and how high, deep, and wide the table should be. Another important point we needed to consider was the reachability of children with and without wheelchairs.

Since we are going to work with colors and sounds, we also had to do research on that. What colors are best for children with color-blindness for example? What kind of sound do we use and how loud should it be?
Knowledge about this was gained via diverse sources, for example internet, articles and asking experts.

2.4.2 Design

To gain more information about the design, we used examples of products that already exist. We saw different shapes of tiles and floors. We also had a look at different materials we could use for the tiles and possible color combinations. We collected as many ideas as possible and later we would decide what was the best for our concept.

2.4.3 Electronics

It was important that we did research on how to actually make this kind of component. We saw some videos about the process of other interactive floors or walls. Not only the building process was interesting, but also the way they generate energy.

2.4.4 Game value

Of course, the games are very important for the component. We also gained a lot of knowledge about different games and interactions that are used in similar components.

2.4.5 Materials

Without good materials, we can't make a good product. Products need to be strong enough to carry children and their helping aids. It also must be waterproof and can't get too hot when the sun is shining. We looked around for different materials that we possibly can use for the concept.

We also had to know which materials we wanted to use to get an idea on the costs.

2.5 Design concept

The duration of this phase was about three to four weeks. After researching what the possibilities were for the concept, we started designing. Some aspects for our concept are not possible for our prototype.

Therefore, we divided our process into two folders "prototype" and "concept".

2.5.1 Prototype

It is very important to start with making sketches and drawings to have a clear view on the measurements of the prototype. Since we need to know how much we need of each material, Mateusz made a technical drawing and decided on the materials we are going to use.

We also had to decide on the games and interactions we wanted to implement. For this we had a lot of ideas, however, we had to consider what would be possible for us with the available time and materials.
To make sure everyone was on the same page, we created a document with all the specifications of the prototype including the dimensions, energy supply and much more information.
We decided on four games we wanted to make for the prototype: whack-a-color, song game, sweeper game and drawing game.

2.5.2 Concept

Like mentioned before, it was not possible to create the concept exactly like we wished. We did not have enough time, money and materials for that. To familiarize you with our vision, we created the “concept” folder in our Teams.
Just like we did for the prototype, we made a document with all the important details.
We made sketches to see how the component would look.
We decided on a name for the component: LED’s Play. An identity was also made: an own font, style etc.

2.6 Create

In this phase we started creating. First of all we created the prototype, but we also wanted to make an animation of the project. We thought that this would be nice to get a better view on how the concept would look and how it would work. Indra started to learn how to use Blender (the program she used to make the 3D model). The assembling of the video and adding the text was done in Adobe Premier.
The building of the prototype went with ups and downs. There were some problems that retarded the process, for example: bad quality of the materials, inaccuracy of the printer, lack of materials… We tried possible solutions but unfortunately, we were not able to finish the prototype to our requirements.
Our sponsor told us we could buy whatever we need but we first needed his permission. Before we bought materials, we sent a mail to our client. Once we got permission, we ordered/bought the materials. We collected the receipts so we could

all send them to our sponsor to get our money back. Gamze was responsible to buy materials and she made an Excel with all the expenses. In our opinion, it was the easiest to do it this way. The right person would receive the money and we would not be struggling to know who bought what.

2.7 User testing

Of course it was really important to test the prototype with our target group. They have to like it and have to be able to use it. We went to two schools and a fair to get feedback from experts and experience experts. We had about one week to test it and improve the concept/prototype.

2.7.1 REVA-beurs (Ghent)

This fair was about everything that has to do with revalidation. We went here because there are a lot of professionals who could give us feedback. Unfortunately, the fair was a little too early to have our prototype finished already. We could show them the board with the LED's but the games were not programmed yet. We could however show some previews on the board. We received a lot of positive feedback. Some of the visitors asked where they could buy it or if we had a website where they could find more information. We also got some good ideas to improve our concept. For example for the blind children: let them follow a track by giving them tactile information through the floor.

2.7.2 Ritmica

The 8th of June, we went to Ritmica to test the prototype and to get feedback from the children. We worked really hard but we could not show them the prototype we wanted. The games were not working like we expected. Luckily, in the end, the children did enjoy it even with a few errors. For example, sometimes when an LED was touched, random other LED's went on. Of course, some LED's not reacting to touch was not good and the children did notice this.

Most of the children that came to test the prototype were children with ASD[3] or ADHD. In the end, the children did enjoy the prototype and were curious to use it.

2.7.3 Heder

On the 13th of June, we went to Heder. Just like Ritmica, Heder is an organization for children with special needs. We could test our prototype in the school. Two games were working. Sometimes a sensor was not really sensitive but overall, the testing went well.

The children who tested were mostly children with ASD or CP[4].

3 Deliverables

Besides from this report, we also had to submit some other deliverables for the client and the school.

3.1 Prototype

The first important deliverable is a well-working prototype. We made a table version of the interactive floor. We programmed four games/interactions. Of course, it was not possible to make the prototype exactly like we want to have our final concept.

3.2 Market and financial analysis

For the client it is very important to know who are the competitors. Is the component something that is already in abundance? It would not be beneficial to develop something that is already sufficiently available. If we decide that there is no abundance, there probably are still competitors. Who are they? How can we distinguish ourselves?

[3] Autism spectrum disorder (ASD) is a developmental disability caused by differences in the brain. People with ASD often have problems with social communication and interaction, and restricted or repetitive behaviors or interests. People with ASD may also have different ways of learning, moving, or paying attention. (Centers for Disease Control and Prevention, 2022.)

[4] Cerebral palsy is the name for a group of lifelong conditions that affect movement and co-ordination. It is caused by a problem with the brain that develops before, during or soon after birth. (NHS,2018.)

Another part is the budget. How much budget do we need to build the component? Is it profitable? We would not take the risk to lose money.

3.3 Product and design concept

To give a clear and detailed view on the concept, we had to make the product and design concept. Here we give a visual presentation of the concept.

3.4 Proof of concept

To know whether people are interested in our concept we have made the proof of concept. Is it necessary to make it? The client does not want to produce something that is not wanted by the customer. So we have to convince the client that this is something important and that a lot of people would like to buy.

3.5 Design logbook

You can see the whole process, the making-off of this project in this file. Every little step concerning the concept or the prototype is written down.

3.6 Presentation

On the 22nd of June, we have to present our project. This way everyone knows what we did, how we did it, what the challenges were… We wanted to create a presentation that was interactive and creative. We chose to do this by organizing a quiz. The winner(s) received a prize and could test the prototype.

4 Monitoring

Every team needs some kind of monitoring to work efficiently, and so did we. We had some rules, roles and tools to ensure everything went smoothly.

4.1 Rules

In the beginning of the project we made rules so everyone knew what was expected and what the implications were when someone did not follow set rules. To ensure that the productivity was maintained, we established five ground rules:

1. No phones allowed during meetings
2. Be on time
3. Always notify when you will not be available/late (WhatsApp)
4. Be respectful for everyone's opinion
5. Do your work on time

If someone broke a rule, this person had to treat the whole group with something small.

4.2 Roles

There were some important roles we had to divide. Every role had certain obligations.

1. **Team Leader**: Indra. We chose the team leader by voting. Indra had the most experience in projects so we almost unanimously chose her to be the leader. The team leader is responsible for the team and the organization.
2. **Contact person**: Lindsay. The contact person stays in touch with all the different parties. When we contacted school, wanted to go to a fair, wanted to plan a meeting with the client… Lindsay made sure that the contact went smoothly.
3. **Archivist**: Gamze. The task of the archivist was to collect and keep up all the documents. The archivist also makes sure that everyone knows where they can find everything.
4. **Chair(wo)man**: changed weekly. The team leader made a schedule. Every week there was a new chair(wo)man. The tasks for this role were: preparing the meetings, checking if everything was done, managing the time and making sure everyone is involved and get the chance to speak.
5. **Notetaker**: changed weekly. Also this role changed every week. The notetaker took notes during meetings and wrote the daily reports (we will talk about these further in this report).

4.3 Tools

We used some tools to monitor our process and work together.

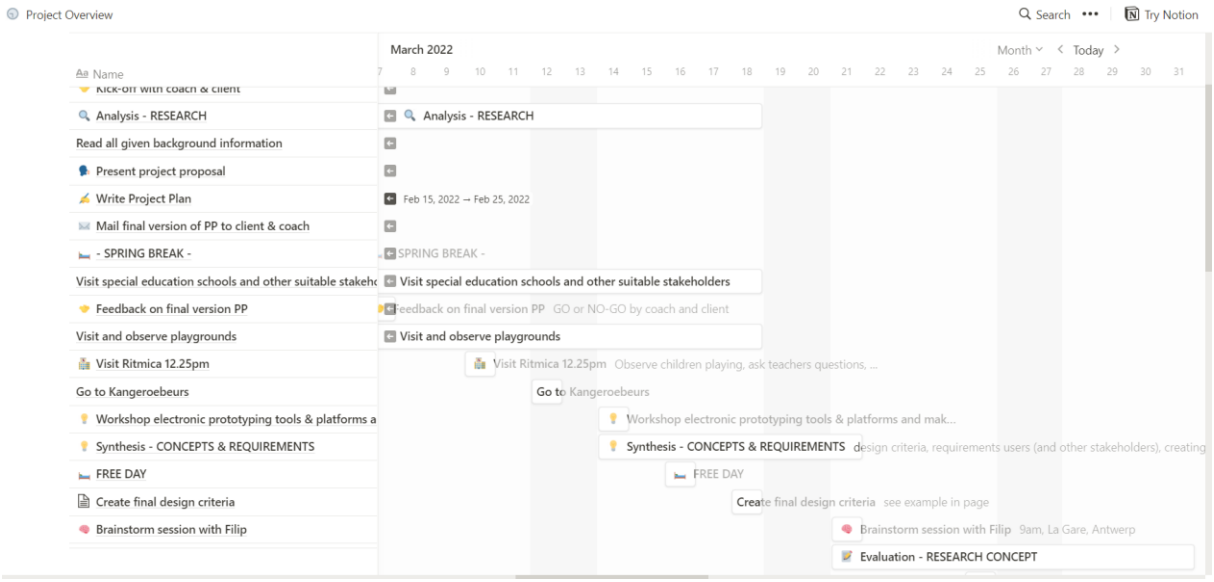
4.3.1 OneDrive/Teams

All the documents, drawing, photos… were uploaded on the OneDrive on Teams. This made that everything was collected on one platform. There were clear folders so everyone knew where to upload their documents.

We mostly did meetings on campus but when someone could not make it to school, our meetings were held via Teams.

4.3.2 Notion

A project overview was made in Notion. It gives a visual view on the process and the most important milestones. A full overview can be found in the appendices.



4.3.3 Todoist

We used this tool to put all the tasks in. We can assign them to the correct team member(s), put a deadline on it… This makes it really clear to see what still needs to be done and what's already done. It is easy to check off the task after you did it, so everyone knows it is finished.

Since we upgraded the app, we were able to use it with the whole group. The upgrade costs four euros/month, so we each paid 50 cents each month.

4.3.4 WhatsApp

When we wanted to communicate quickly we used WhatsApp.

5 Contributors

Of course, we could not do this whole project on our own. There were a lot of contributors that have helped us during the whole process.

5.1 Supportive courses

AP organized some supportive courses to help us in the project.

5.1.1 Entrepreneurship and corporate communication

During this course, taught by Nathalie De Schepper, we learned how to make a business plan. For an entrepreneur, it is really important to have a clear view on the target group, goal, partners… we had to make a business plan for our project as well. Another thing that is necessary is pitching. First we got all the theory about the do's and don'ts when you pitch your project and afterwards it was our turn. We got feedback on the pitch we prepared.

We also had to make a logo and a video to promote our concept. We learned this during the cross-media and audiovisual communication classes. This part of the course was given by Lina Delafortry.

5.1.2 English language and presentation skills

The main language during this project was English. The presentations, reports and assignments should all be in English. So, it was important that we had enough knowledge to use proper English. We learned some grammar with the aim of being able to give your opinion. During this course we had the chance to ask feedback on our reports and other preparations regarding the English language. This course was taught by Joos Vollebregt and his intern students (Dries, Gianni, Freikje, Sarah and Wenke).

During this semester we had to do two big presentations: the midterm presentation and the end presentation. From Nathalie De Schepper we got some tips how to

behave while presenting. How do you stay in front of an audience? How do you start a presentation?... We were taught all the tips and tricks in this course.

5.1.3 Cross-cultural exploration

In these course, we were put in Teams that were different from our project teams. Depending on what subject you picked at the start of the course, you organized all kinds of activities. The aim of this course was to get to know each other and the culture of others better. Our team members participated in the selfie trip and popcorn time group. The selfie trip group had to organize trips with different stops in Antwerp. The popcorn time provided really nice movie nights at school with movies from different cultures.

5.2 Stakeholders

In every project there are a lot of stakeholders involved in the project. People who are supporting you, the target group you're making it for…

5.2.1 Clients

Of course there would not be a project without our clients. They started the whole project and gave us the assignment to design an inclusive play component.

Our first client is Filip Gerits who represents KBT. Filip is a research and development manager and product design and product manager at KBT. KBT is a manufactory, based in Belgium, Sint-Amands. Their main focus is to introduce new items based on their own imagination and requests from KBT customers that are safe and exciting. They produce these components for residential and commercial playgrounds. Filip was really involved during the whole project. He gave us brainstorm and technical workshops for example. We had several meetings and could always ask him for feedback. KBT was also our sponsor. They paid for the materials we needed for the prototype and other costs we had to make.

Our second sponsor, Kathleen Op De Beeck is an occupational therapist and a teacher at AP University. She teaches the occupational therapy students a few courses. Leen has much knowledge about children with disabilities and she gave us really useful feedback when it came to disabilities and children. She also had a lot of contacts we could use for the project.

5.2.2 Coaches

Hilde Van Himbeeck and Erwin Listhaeghe also had an important role as our coaches. We had weekly meetings where we talked about the progress and the problems we had. They always gave us good advice so we could go on with the project. Besides the meetings we could always send them an e-mail when we had other issues. They were a big support for the whole project team.

5.2.3 Project team

As the project team we had the task to create the idea and the prototype so, of course, we were a really important stakeholder as well. We decided what we would make and how it would look like, always with feedback from the other stakeholders of course.

5.2.4 Children and their parents

Since children are our target group it was necessary that we involved them as well. We constantly asked for the children's and their parents input. Firstly, we asked them what problems they had at the current playgrounds and what they liked. This way we got to know their gains and pains we used to create an idea. Secondly, we asked for their feedback on the concept. Finally, we tested the prototype with them. We thought it was important to involve them as much as possible since they have to use it in the future and only they can say whether they like it or not.

5.2.5 Makerspace

Sanne and Jonas from the Makerspace gave us the opportunity to make the prototype. We had all the materials and space we needed. They always wanted to give us advice and they helped us with the printers, lasercutters, …

5.2.6 Schools and other organizations

The schools and organizations also had to give their feedback because they have a lot of knowledge and they might be future buyers. We asked organizations like “Braille Liga” for their feedback and went to some schools.

6 Strengths and challenges

Like in every team and project also we had some challenges and things we were good in.

6.1 Strengths

One of the strengths in our team was that we are a very diverse team. We have a lot of different fields of educations in our team. This way, we were able to learn a lot from each other on all kinds of aspects.

During the phase we were making the prototype there was a lot of work to do. Every team member, even the non-technicians, helped. When someone needed help, there was always someone else in our team that wanted to do so.

We had a safe environment in our team where everyone could say what he or she wanted without being judged. We all think it is very important to feel good in a team.

6.2 Challenges

The communication and motivation in our team was a real challenge. This was clear from the beginning of the project. We did not really know what the others were doing or all the work was done by the same people. We talked about this with our coaches and they suggested some solutions for us. First of all we started making daily reports.

We wrote down who did what and sent these reports to the coaches as well. Secondly we started working with a “traffic light system” ,which means that every day we told each other how we were feeling. We did this during the meeting but quickly we noticed that this was not an efficient way. This is why we started making daily written evaluations. We said how we were feeling and why, what could be improved and told how we were feeling towards the others. This helped to communicate transparently. Although there were sometimes still things that were not told that led to frustrations.

Ali had some language issues in the beginning of the project. This was a challenge for the team but we were all very clear that we wanted Ali in our team. He’s an added value and we all wanted to help him improve. Luckily, Gamze speaks Turkish so she could help him translate. Of course, he had to learn how to communicate without always asking Gamze to translate. He used apps to translate and the rest of the team was very patient. During meetings the chair(wo)man checked regularly that he understood everything. His English improved every week and we are very proud of how far he has come.

Another challenge we had was that it took us longer than expected to finish the prototype due to technical issues. We had to reschedule some things or could not test it like we wanted. Everything was delayed which led to everyone being stressed. We tried to do as much as we could in advance so we would not lose too much time. For example, we started thinking about how we wanted to do the presentation.

Project Results

Our group was able to create not only an inclusive, interactive, and electronic toy concept but also managed to deliver a working prototype. Besides that, we also documented our work progress in steps and summarized it in recommendations and challenges for future groups to follow. The goal of this semester was to become an efficient and good working team of students with one leading vision. This vision was the motivation to create an inclusive playground component for our sponsor KBT. In the matter of delivering a working prototype, we followed the recommendations of our sponsors and coaches. During the whole progress, we often came across issues that took us steps back. However, with advice and comments from our coaches, we were able to follow our goal. Decisions and steps were first discussed internally and then got approval from our sponsor and coaches. Coaching, research, and meetings with our sponsor were our guiding principles

Beginning this semester, we had many different ideas for our concept and while creating we wanted to keep most of them in our concept. Time limitations were the reason for then evaluating and agreeing on certain points.

Initially, we wanted our prototype to be an exact demonstration of our created final concept. Resources and strict timelines made us decide on delivering a small version of the floor with main functions like sound and color change. Components such as the table and functions like vibration were not included in our prototype. Nevertheless, those features are detailed and described in our final concept.

As a group, we are proud and happy about our results and work. All of us worked hard and tried to make it the best version possible. However, there were points in the concept and prototype we would have liked to improve or change during our process. Unfortunately, those aspects like designing and creating a more stable box and cover for our prototype couldn’t be followed due to lacking time. Instead of focusing on the details, we didn’t implement, we are relieved and value our achieved success.

The most important thing we learned during this project was how to use our abilities and knowledge the best when it comes to working in big groups without any preparation. Our working prototype shows that organization and coordination are big factors when achieving goals. Coming from different backgrounds and study fields, we were able to learn from each member of the team. The shared knowledge gave us the opportunity to dive into new subjects. While working together, we also learned that communication and personal responsibility was important factor we needed to improve. As a team, each member has a major impact on achieving the goal. Instead of going into decisions separately, possibilities should be discussed as together belonging group. Every opinion and contribution to the project is apricated and valued.

While working and realizing project goals, we kept contact with our coaches and updated our client. This helped us to form a connection and understand the needs and expectations of our sponsor. All relevant data is continuously uploaded and updated on our separate MS Teams group. This way we made sure that, our coaches and client could follow our steps and understand our progress better. At the end of the project, we will deliver the expected data and documents by sending them directly to our sponsor and uploading it in our group and DIGITAP.

Conclusions and Recommendations

8 Conclusions

When we tested the prototype, we got a lot of positive feedback. Some teachers and mentors even asked where they could buy it. The thing that was mostly mentioned as positive were that the lights and sounds attracts the children.
When we saw the children playing they were often laughing so that is a sign for us that they were enjoying it.
They liked a variety of open-ended and ended play. Some of the children did not like the interactions because they did not make sense for them without rules. They first wanted to know the rules before they wanted to play it. Other children really liked the ‘free play’ and made their own rules.
The first time we tested the colors were not always correctly working. This time the children liked the sounds more than the colors. The second time, it was better and we could see that they were focusing more on the colors as well.

Overall, we can conclude that children and their teachers/therapists/caregivers/… like the concept and see potential but there are still a lot of improvements needed.

9 Fails during the project

It's really important to read this document, the most important of all this documentation is to not make the same mistake we made. On this page, I will tell you which mistakes we made and how to prevent them from not making the same mistake, this could be a hardware mistake I made our software also tips to not getting stuck while doing the project.

9.1 Arduino

One of the most important pieces of advice I can give you was not to work with the Arduino. The mistake I made is to work with this and continue working with it till the end. The Arduino has 1 core and isn't capable to do 2 tasks at the same time, for this

we need a multicore microcontroller. The esp32 is an option but you can explore further and see its C++ compatible to program it as well.

while doing the sweeper game I found out it's not possible to let the animation run and sense the touch sensor.

9.2 Nets

while I didn't have enough experience with the capacitive sensor library I still thought the net would work since I saw a similar project on the Internet. I've been months testing it and it gave me a good result but sadly for me while putting 64 nets beneath the board it didn't work because there was a lot of interference. I would say to not spend a lot of time with this and skip the nets I used. I would prefer just to buy some existing capacitive sensor chips and place them. What you also could do is use ir sensors and try it out, You will need to change the code. I would recommend just going with the already existing chip and test id since they are qualified for this kind of stuff. If you still think the nets are still an option just consider it a lot of work soldering the cables to the net and also playing the little squares beneath it since it cannot touch the LEDs.

9.3 Soldering

Soldering took a lot of time while doing the project so I would avoid this kind of work. I would suggest making a PCB on time and implementing everything in it. It took us weeks to finally solder everything. by everything I mean soldering the VCC and GND wire to every led, soldering the data pin from one led to the other, and the cables to the touch sensor. The main reason to avoid this is that you're never sure when they are stuck together or not. even when we thought everything was soldered 1 wire always desolder from the net or led. So if you want to avoid a lot of stress work just make a PCB or just use connectors from one side of the LEDto the other side.

9.4 Multiplexer

the multiplexer had some issues and didn't work as I wanted to work. I first tried to do a 1:64 conversion by using a 4x 1:16 multiplexer and a 1x 1:4 multiplexer and connecting them. but this didn't work so I just used the 1:64 multiplexer and for every output (4) I connected it to the Arduino. if you're trying to do the same and got some problem I would just suggets 1 thing, check every connection and see if some cables aren't loose or disconnected, and please do it good because if you do it quickly like me you could oversee the problem. You can notice this problem when you're looking in the serial monitor of the Arduino to the sensor and you touch 1 but two sensors increase the value. but I repeat if you want to avoid this problem make a PCB and just solder the multiplexer on it.

9.5 PCB

When I tried to make a PCB I encountered problems, problems I could fix but because I made the PCB late I couldn't fix it on time. The problem where the footprint of the multiplexer I found on kicad wasn't the right size and I noticed it when it already was printed. So please measure on kicad (or whatever you're using) the size of the component and see if it really could fit on the board. The PCB machine school had isn't that good and professional so it was really difficult to solder everything since it was really small I would say to make the path bigger or just order from jlc PCB they are more professional. Also when you want to use the bottom at the top you need via's and to connect those two you need Voltera Rivets or a tiny copper wire and solder it. This is difficult and not efficient so you need to be aware of this. Volterra Rivets are not available at school so you need to buy them. Overall I would just suggest buying it from china on time because you need to test it and improve it.

9.6 Code

I had some trouble making everything work in 1 code but I finally managed to do but it's not perfect. you can change the state by pressing a button but these are all in the comments for now. I don't know if it's helpful but I will put it also on Github. The thing I encountered was sending bits to the multiplexer. Please do not change it and try to

use the same I used. it is the best way to do it. If you're going to use the same things I used then you should use the code I wrote otherwise you need to figure it out yourself.

10 Improvements

10.1 Improvements prototype

We were not able to make the concept we had in our minds due to lack of time, money and knowledge. Of course we have some things we want to improve that are possible for a next group or for our client. Hereby, the improvements we recommend for the prototype.

10.1.1 Hardware

Since the touch sensors and other things like the Arduino didn't work well we've been thinking of a solution to improve it. firstly, to make it possible to add some games and at the same time touch the sensor. For this you need a microcontroller with multiple cores so that you can process 2 things at the same time. Unfortunately, the Arduino has a single core and cannot be used to provide games like whack a mole or sweeper since you need to do the sweeper animation and also track the touched tile. I would recommend testing or to investigate more about the esp32(dual core). You should avoid any Arduino microcontrollers.

Now about the sensors, the sensors could be improved by using a sensor ic (integrated circuit). You have many chips that can be used for this but in our eyes, the cap1203 is the best one, this has only 3 inputs but if you want 8 or even 15 inputs for the sensors you should look at the cap1298 or MTCH 6102-I. instead of soldering every sensor to the top of table, you can make a big PCB with the ic. By doing this you do not need the capacitive sensor library or multiplexer anymore since this ic works with i2c communication.

To improve the games we need extra hardware, in our point of view, you can implement a buzzer or vibration motor to make it more attractive and give the

children feedback. my recommendation is to use first the pre-made PCB vibration motor to test it and afterward, you can implement it in a PCB sketch or in the sensor tile you're making.

10.1.2 Code

The code is now specially written for the hardware we use. The algorithm we used to make the game will be probably the same so you should look at it and try to understand it. To improve the code you should look first at the hardware you decided to make and remove the libraries you are not using. We are sure you should not remove the FastLed library since the LEDs need that library to work. We do not know if the code is compatible with the esp32 but we think it is. The library that might not work with the esp32 is the midi library.
To make it easier for the next group, so they do not make the same mistakes. All the information about the electronics part is written down. They can find it here: https://andresdavalosc.github.io/LedsPLayInstructions/#/

10.1.3 Design

The plan changed last minute so the box we made did not fit anymore. Next year, they can make a box where all electronics fit in. It is safer and looks better.
We recommend making an 8 LED’s by 8 LED’s prototype instead of a big one. This means that you have less soldering work and you can focus more on the connections. There are less wires etc needed what makes it easier.

10.2 Improvements concept

For the concept we recommend the following improvements.

10.2.1 Floor

A really good suggestion we got from “Braille Liga” was to implement tactile input for the blind and visually impaired children. This way they can make their own rules and

games on the floor and it is challenging as well. They will feel more sure on the floor because they have some kind of support.
For now we have one big floor. To transport it, it would be easier to have 64 separated tiles. The next group can think about how to make this possible. This way, the customers can also choose how many tiles they want and they can compose their own floor.
The material for the floor has to be something transparent, waterproof, heatproof and anti-slip. We could not find something that matches with all requirements. Around the floor we were thinking to use an EPDM rubber flooring. When it comes to the material itself the aluminum alloy 6061 since it has low density, so the body of the floor is not so heavy. What is more, this alloy can be easily welded using TIG or MIG method. It is also possible to galvanize this material to make it smoother. For the concept the plexiglass was chosen but there might be some other solution for the floor.
For the safety of the blind children, we think it is useful to have attention markings around the floor.

10.2.2 Table

We wanted to make the table adjustable in height. We could not find a design that was safe, adjustable in height and possible. Another idea we had for the table, we were not able to find a design for was make a cocoon. It is proven that children feel more safe when their back is covered.
Since our theme is ‘space’ we thought about implementing LED’s on the side of the table’s legs.
We thought about making the tiles vibrate so they can “feel” which tile they have to touch. Vibration can also work as output, for example when they do something the tile vibrates.
For the table we need materials that are smooth so children can’t hurt themselves while exploring the component. A design where all wires and electrical stuff can be tucked away safely, is necessary. In order to do that the construction steel S185 was chosen. This type of steel can be also easily welded and galvanized. Furthermore,

the material we needed to choose must have been sustainable enough so the component does not break so easily.

10.2.3 Games/Interactions

10.2.3.1 General

The games and interactions can be improved for the blind or visually impaired children. We thought about implementing a voice assistant for the whack a color game for example. The voice assistant can guide the person to the right tile by saying the right letter and number. With the help of the braille signs on the floor they will be able to find the right tile.
For wheelchair users we can implement a 5-second rule. When they stay on the same tile for 5 seconds it is registered and the floor reacts.

10.2.3.2 Sweeper game

At this point, the sweeper game is in the first place interesting for the floor. To make it more interesting for the children who want to play on the table we thought about letting them manipulate the sweeper line. This way they can “trick” the children on the floor and make it more difficult for them.
For wheelchair users, there can be a little gap in the line so they can go through it instead of jumping over it. Another option would be to make it go around instead of going from the left to the right.
The line of the sweeper can also be like a wave of the sea. Or maybe something space themed?

10.2.3.3 Song game

After some time they games change. During Christmas time, christmas songs are played. Around Valentine, there are love songs,…

10.2.3.4 Whack-a-color

Children in a wheelchair can sit down or lay down on the ground. They can all be in charge for a part of the floor. This way they can play together.

10.2.3.5 Modes

We would like to implement a button where they can change from interactive mode to game mode. Every time they spin the button a new game appears until they stop spinning. Then they can start playing.

Another thing we want for the concept is a manner to choose different modes for the component. The different modes we thought of: wheelchair, colorblind, blind, epilepsy and less input (more silent, less bright colors).

10.2.3.6 Extra games and interactions

The games we thought of to add as well:

- Make your own farm: they can make their own vegetables grown
- Emoticon: the mood of the emoticon changes when they are jumping on the floor
- Paint splatters: the harder the kid jumps, the bigger the splatter
- Bubbles: they can pop the bubbles or make them.

10.2.4 In- and output

It would be very nice if we could connect the helping aids of the children, for example a button, joystick or eye movement tracking technology. We thought about light, sound and vibration as output.

To generate energy we hoped that it would be able to do it with green energy such as sun panels. Eventually we wanted to let the children generate the energy themselves by jumping on the tiles. The mechanical energy could be changed into electrical energy.

List of References

Centers for Disease Control and Prevention. (2022, 28 maart). Signs & Symptoms | Autism Spectrum Disorder (ASD). Geraadpleegd op 14 juni 2022, van https://www.cdc.gov/ncbddd/autism/signs.html#:%7E:text=Autism%20spectrum%20disorder%20(ASD)%20is,%2C%20moving%2C%20or%20paying%20attention.

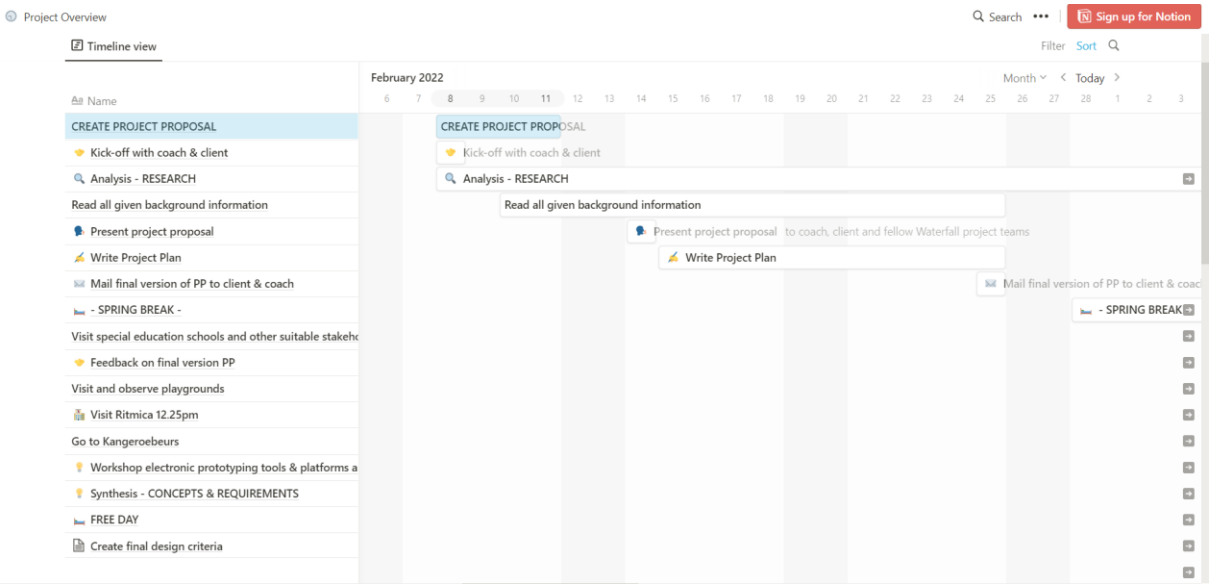
NHS website. (2021, 18 november). Cerebral palsy. Nhs.Uk. Geraadpleegd op 13 juni 2022, van https://www.nhs.uk/conditions/cerebral-palsy/#:%7E:text=Cerebral%20palsy%20is%20the%20name,during%20or%20soon%20after%20birth.

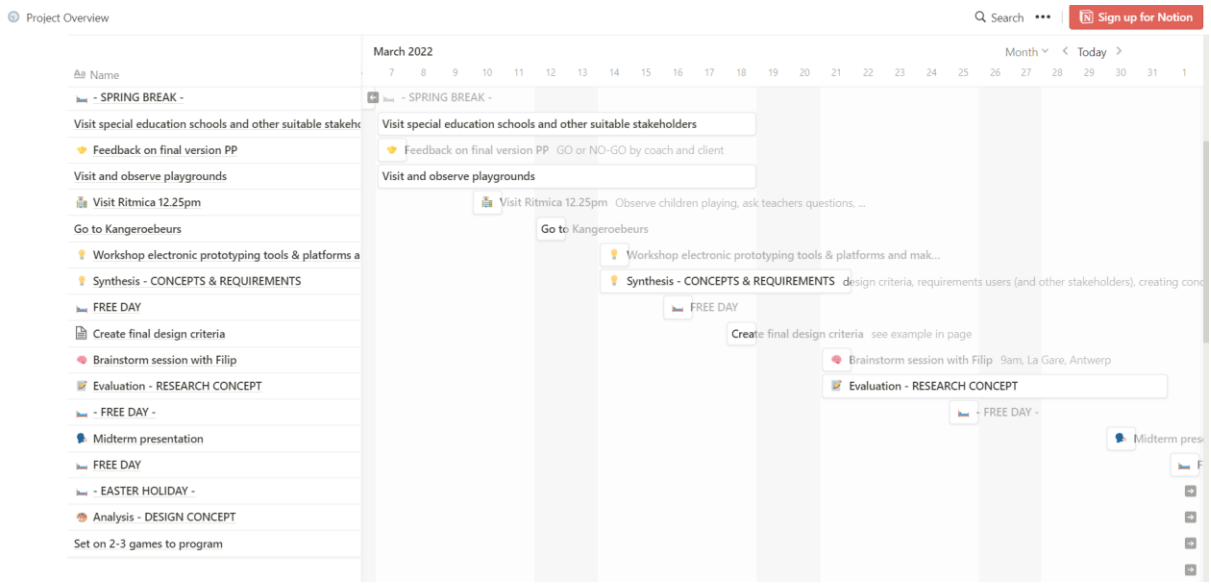
OHCHR. (1989, November 20). Convention on the Rights of the Child. Retrieved May 12, 2022, from https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-child

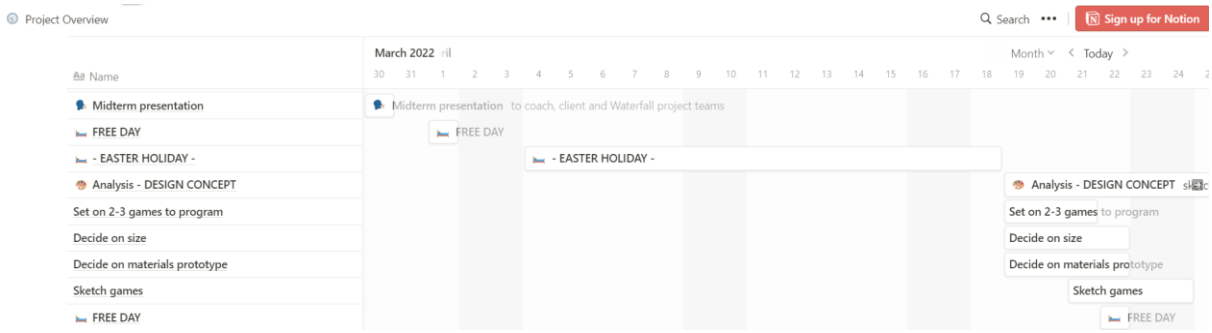
Appendices

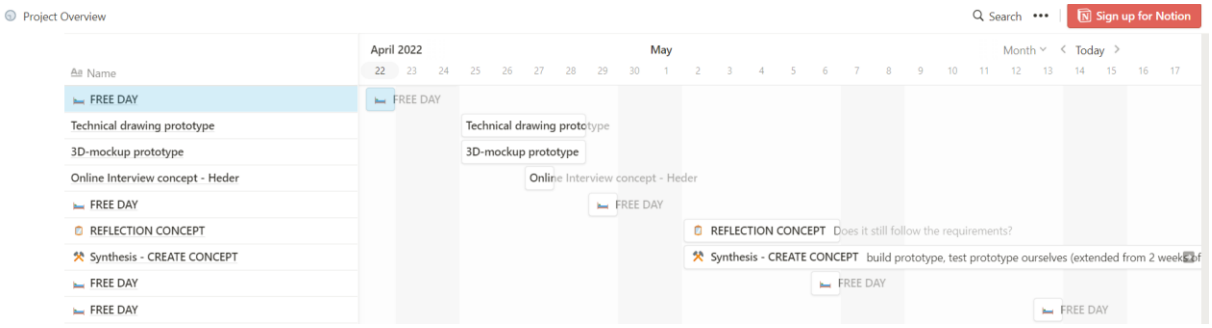
11 Overview

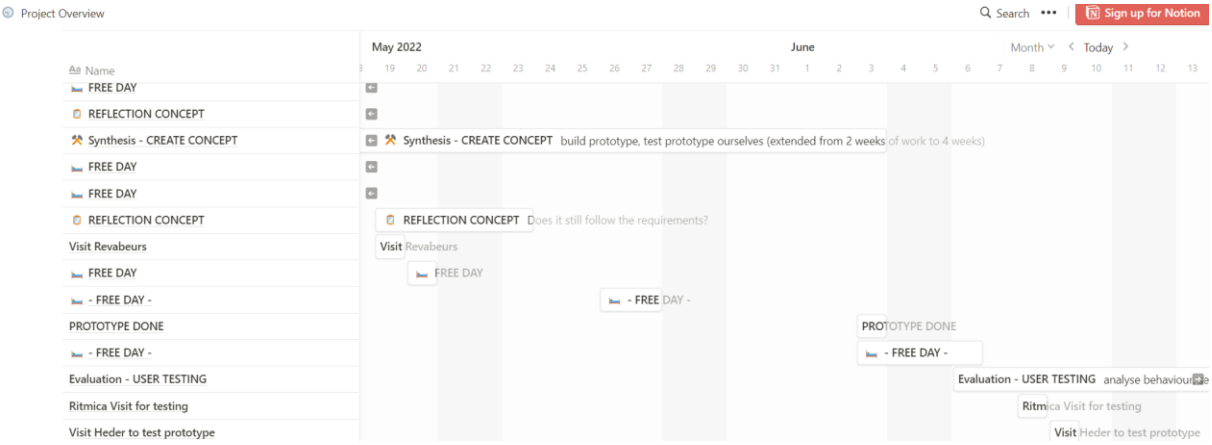
Via this link you can see the overview. Below we added screenshots of the whole timeline as well. https://northern-zenith-e94.notion.site/fac4406b5dca4c588dc854246799a458?v=4aab141acf4a4c1ba1e4e1d1ccc8a139

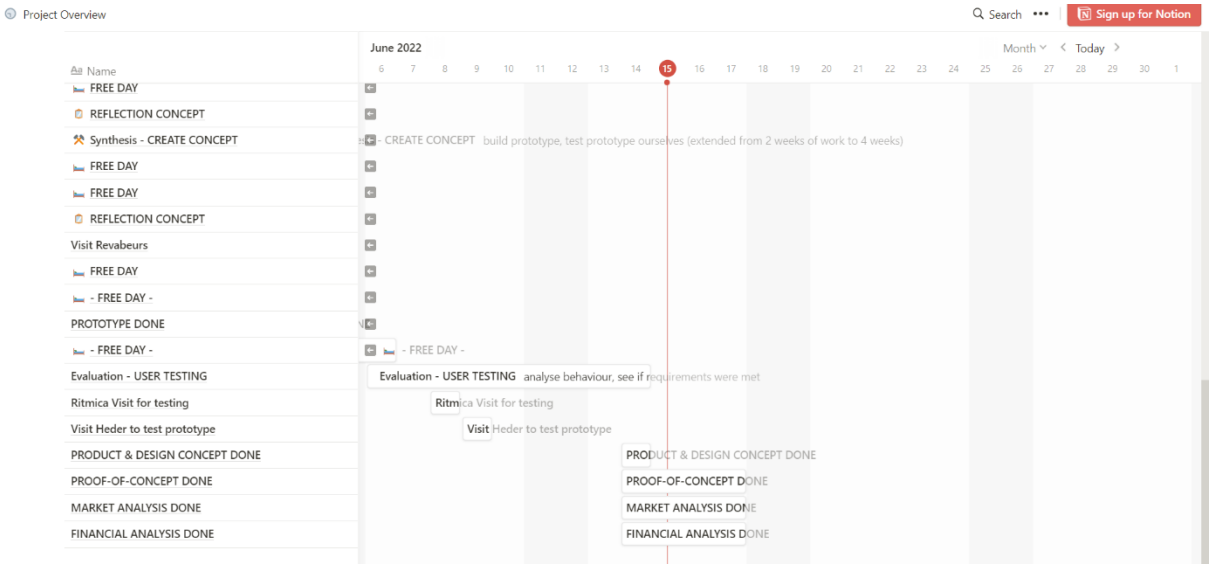




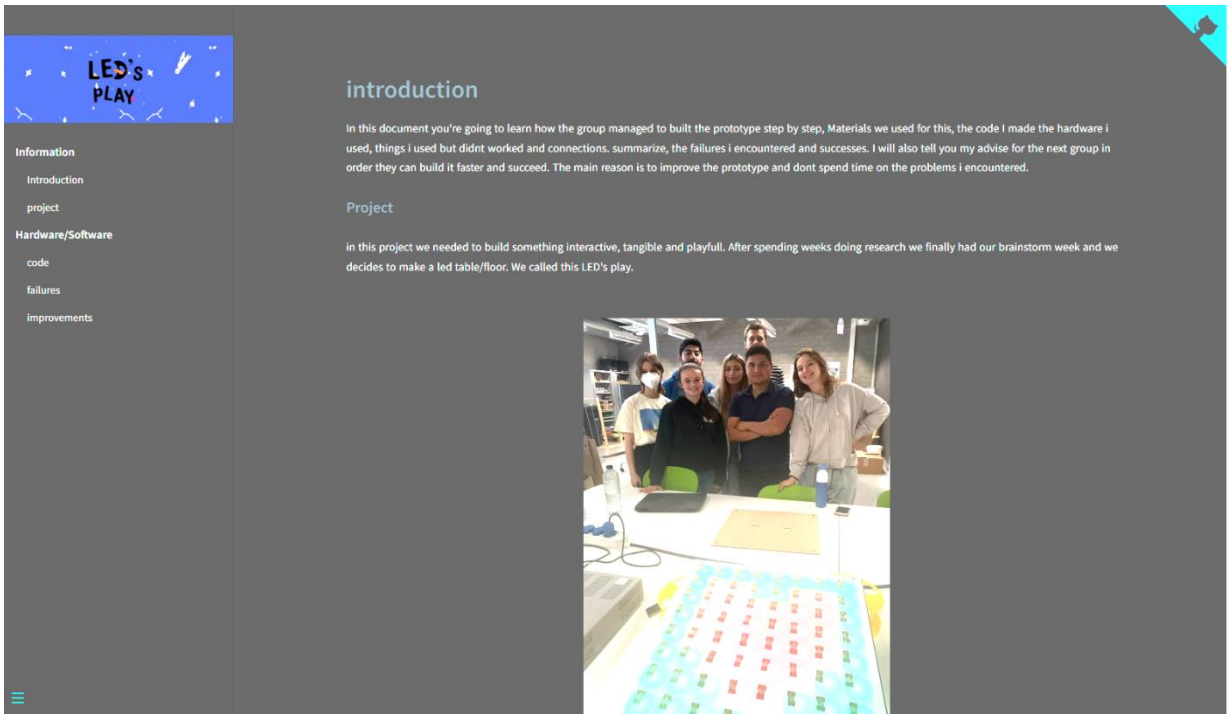

Project Overview
Search
Sign up for Notion
March 2022
Month
Today
Name
Midterm presentation
FREE DAY
- EASTER HOLIDAY -
Analysis - DESIGN CONCEPT
Set on 2-3 games to program
Decide on size
Decide on materials prototype
Sketch games
FREE DAY

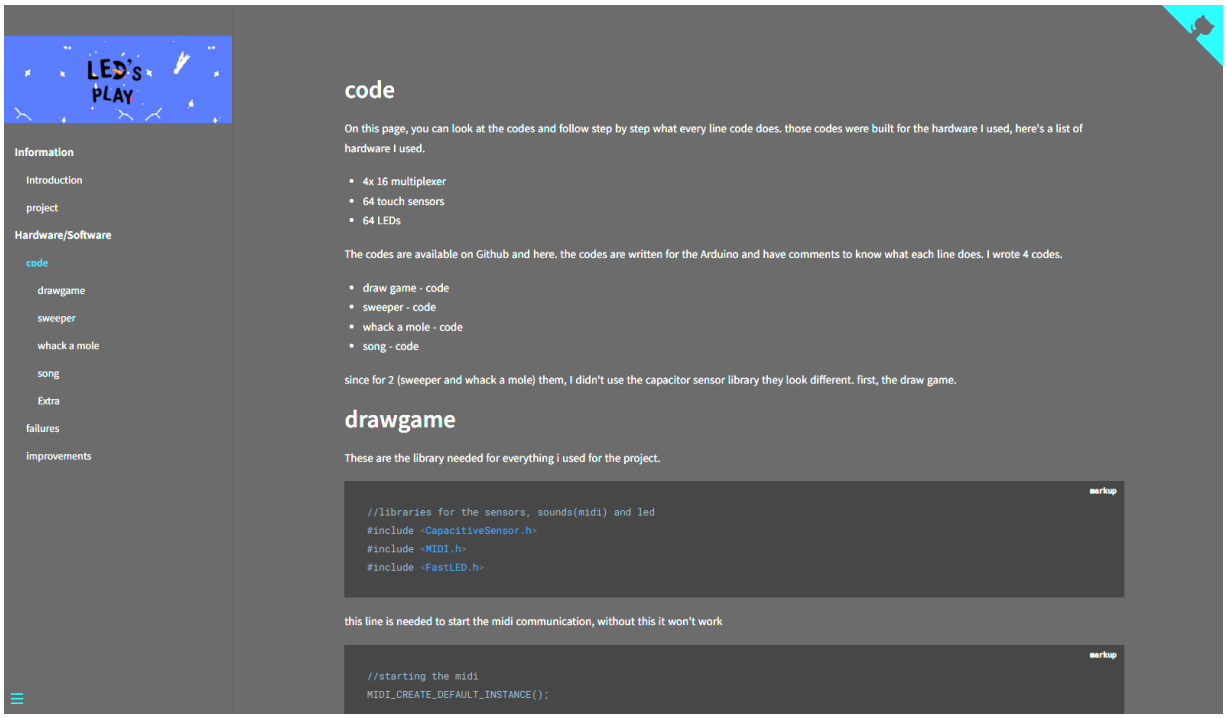

Project Overview
Search
Sign up for Notion
April 2022
May
Month
Today
Name
FREE DAY
Technical drawing prototype
3D-mockup prototype
Online Interview concept - Heder
REFLECTION CONCEPT
Synthesis - CREATE CONCEPT
build prototype, test prototype ourselves (extended from 2 weeks
Does it still follow the requirements?

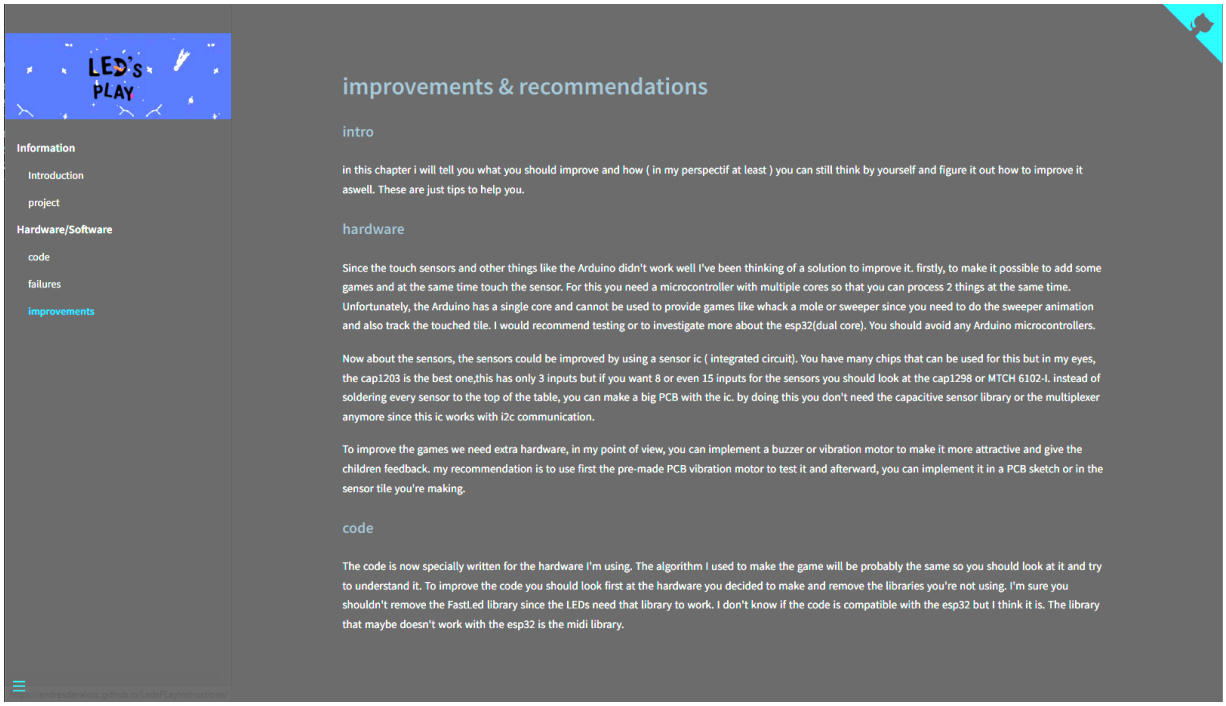

Project Overview
Search
Sign up for Notion
May 2022
June
Month
Today
Name
FREE DAY
REFLECTION CONCEPT
Synthesis - CREATE CONCEPT
build prototype, test prototype ourselves (extended from 2 weeks of work to 4 weeks)
Visit Revabeurs
- FREE DAY -
PROTOTYPE DONE
Evaluation - USER TESTING
analyse behaviour
Ritmica Visit for testing
Visit Heder to test prototype


Project Overview
Search
Sign up for Notion
June 2022
Month
Today
Name
FREE DAY
REFLECTION CONCEPT
Synthesis - CREATE CONCEPT
build prototype, test prototype ourselves (extended from 2 weeks of work to 4 weeks)
Visit Revabeurs
- FREE DAY -
PROTOTYPE DONE
Evaluation - USER TESTING
analyse behaviour, see if requirements were met
Ritmica Visit for testing
Visit Heder to test prototype
PRODUCT & DESIGN CONCEPT DONE
PROOF-OF-CONCEPT DONE
MARKET ANALYSIS DONE
FINANCIAL ANALYSIS DONE

12 Electronics






LED's PLAY
Information
Introduction
project
Hardware/Software
code
failures
improvements
improvements & recommendations
intro
in this chapter i will tell you what you should improve and how (in my perspectif at least) you can still think by yourself and figure it out how to improve it aswell. These are just tips to help you.
hardware
Since the touch sensors and other things like the Arduino didn't work well I've been thinking of a solution to improve it. firstly, to make it possible to add some games and at the same time touch the sensor. For this you need a microcontroller with multiple cores so that you can process 2 things at the same time. Unfortunately, the Arduino has a single core and cannot be used to provide games like whack a mole or sweeper since you need to do the sweeper animation and also track the touched tile. I would recommend testing or to investigate more about the esp32(dual core). You should avoid any Arduino microcontrollers.
Now about the sensors, the sensors could be improved by using a sensor ic (integrated circuit). You have many chips that can be used for this but in my eyes, the cap1203 is the best one,this has only 3 inputs but if you want 8 or even 15 inputs for the sensors you should look at the cap1298 or MTCH 6102-I. instead of soldering every sensor to the top of the table, you can make a big PCB with the ic. by doing this you don't need the capacitive sensor library or the multiplexer anymore since this ic works with i2c communication.
To improve the games we need extra hardware, in my point of view, you can implement a buzzer or vibration motor to make it more attractive and give the children feedback. my recommendation is to use first the pre-made PCB vibration motor to test it and afterward, you can implement it in a PCB sketch or in the sensor tile you're making.
code
The code is now specially written for the hardware I'm using. The algorithm I used to make the game will be probably the same so you should look at it and try to understand it. To improve the code you should look first at the hardware you decided to make and remove the libraries you're not using. I'm sure you shouldn't remove the FastLed library since the LEDs need that library to work. I don't know if the code is compatible with the esp32 but I think it is. The library that maybe doesn't work with the esp32 is the midi library.