



Appendix

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Appendix A - Project Brief

DESIGN
FOR OUR
future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

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

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according to the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name	Muller	Your master programme (only select the options that apply to you):
initials	S given name Sven	IDE master(s): ☐ IPD ☒ Dfi ☐ SPD
student number		2 nd non-IDE master:
street & no.		individual programme: (give date of approval)
zipcode & city		honours programme: ☐ Honours Programme Master
country		specialisation / annotation: ☐ Medisign
phone		☐ Tech. in Sustainable Design
email		☐ Entrepreneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	A.P.O.S. Vermeeren	dept. / section:	HICD
** mentor	M. A. Gielen	dept. / section:	DCC
2 nd mentor	Diederik Veerman		
organisation:	Museon-Omniversum		
city:	Den Haag	country:	The Netherlands

comments
(optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

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

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair A.P.O.S. Vermeeren date 05 - 09 - 2023 signature Arnold Vermeeren

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

Master electives no. of EC accumulated in total: _____ EC	☒ YES all 1 st year master courses passed
Of which, taking the conditional requirements into account, can be part of the exam programme _____ EC	☐ NO missing 1 st year master courses are:
List of electives obtained before the third semester without approval of the BoE	

name _____ date - - signature _____

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?	Content: ☐ APPROVED ☐ NOT APPROVED
Is the level of the project challenging enough for a MSc IDE graduating student?	Procedure: ☐ APPROVED ☐ NOT APPROVED
Is the project expected to be doable within 100 working days/20 weeks ?	
Does the composition of the supervisory team comply with the regulations and fit the assignment ?	
comments	

name _____ date - - signature _____

IDE TU Delft - E&SA Department /// Graduation project brief & study overview /// 2018-01 v30
Initials & Name _____ Student number _____
Title of Project _____

Transform children's perspective through an interactive exhibition in Museon-Omniversum. project title

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

start date 05 - 09 - 2023 16 - 02 - 2024 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Museon-Omniversum's focus as a museum is to educate visitors, mainly families with children, about sustainability through interactive exhibitions. Their current exhibitions are about the 17 SDG's and One Planet NOW!, consisting of 6 different themes (Figure 1), which show solutions to a (more) sustainable future. They challenge visitors' motives towards certain dilemma's and try to change this in a more sustainable/positive way. Museon-Omniversum is constantly looking to update their exhibitions, currently they are designing a new exhibition about new materials and biomimicry, which will be opened in May 2024. This new exhibition will partly replace their current exhibition One Planet NOW!

My interest in museums started at a young age. I believe that museums positively contribute to one's development in defining their own norms and values. Being able to do a graduation project about biomimicry for Museon-Omniversum is a good opportunity to contribute to this process. In addition, to teach the new generation about biomimicry is important. Much room for knowledge-grow lies within this phenomenon. As shown in the figure, one can look at nature to find solutions for different problems (Figure 2). Biomimicry is the term for where one looks at how nature solve problem X. By studying, one tries to apply nature's solution to solve their problem. The exhibition's main goal is that visitors' view will expand, transform and re-program. Biomimicry can spark imaginations and inspires one to look for solutions in nature.

Some examples of principles of biomimicry in relation to innovations and design include:

- Observe & study the situation they want to change
- Stimulate creative thinking & encourages to ask questions (Figure 2)
- Learn about functions and strategies that can be applied in daily life (e.g. Velcro)

Museum Future labs is interested in how minds are transformed during (and after) visiting an exhibition. The museum's role has evolved past the one-sided knowledge transfer it used to have, towards an (interactive) experience. Mathieu Gielen is foremost interested in how the transfer of knowledge to children appears in museums. What effect/impact has playful learning compared to formal knowledge transfer? Museon-Omniversum wants the visitor to discover through interactive (playful) exhibits how nature can help shape the future. New materials and biomimicry are the two main pillars of this new exhibit. They want to display nature as a teacher; How would nature solve this?

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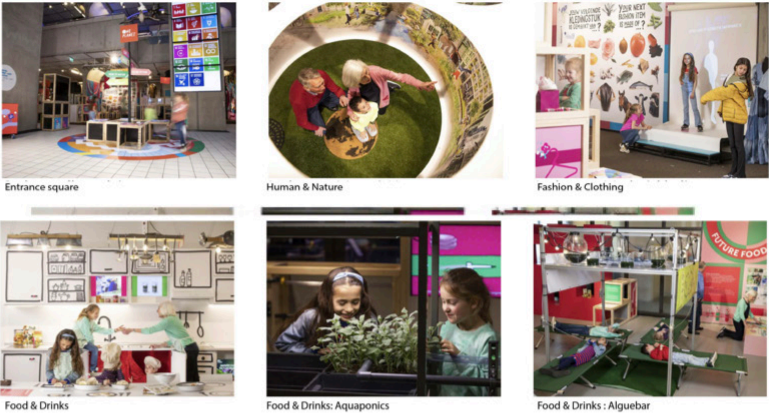


image / figure 1: Current exhibition: One Planet Now, in Museon-Omniversum



image / figure 2: Grid with problems, complemented with solution taken out of nature by Laura Stevens.

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

In this project I want to explore the possibilities an exhibition has to offer to create awareness and simultaneously stimulates transforming one's behaviour in future problem solving. To narrow the scope down, I want to focus on children (8 – 12 years) who come with their family and let them explore the concept of biomimicry through a playful exhibition. My project will be an interactive learning experience that enhances their understanding of biomimicry. The exhibition stimulates them to alter their view on daily life. Creating a way-of-thinking that can help in future-problem-solving by looking for answers outside their daily environment.

This transformative experience consists of four design challenges

1. Awareness – How can you create a spark of curiosity towards biomimicry?
2. Deeper understanding – How can biomimicry help them (in life)?
3. Explore – How can playful hands-on activities help to explore the principles of biomimicry?
4. Integration – How do you implement principles of biomimicry in daily life?

For this project I will focus on the first three challenges: Awareness, Deeper understanding and Exploration. Some research questions that need to be answered:

- What is biomimicry?
- What can children learn from biomimicry?
- How do children (8 – 12 years) gather and process information?
- What is a transformative museum experience?
- How does Museon-Omniversum approach children through their exhibitions?
- How can Museon-Omniversum contribute to a transformative experience in biomimicry?

ASSIGNMENT **

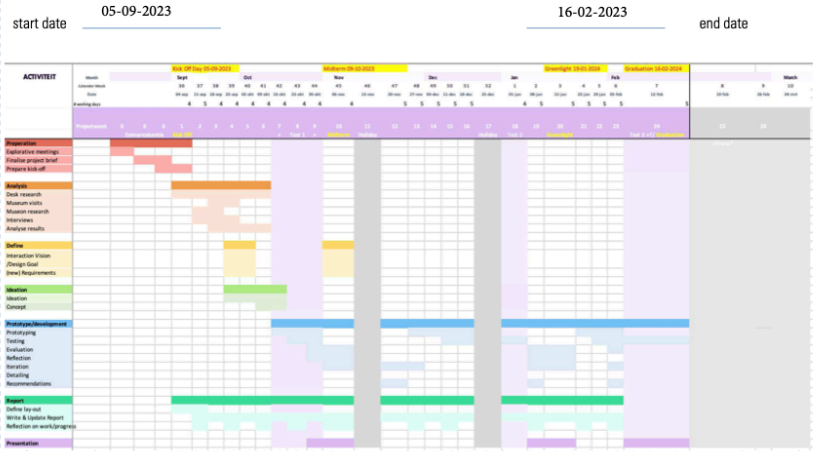
State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Design an interactive exhibition that stimulate awareness & deeper understanding of (phase 1. & 2.) biomimicry in families with children (8 – 12 years) and let them learn in a playful way (phase 3. Explore).

Employing an iterative methodology (as in the course ITD), I will engage in analysis through desk research, context mapping and interviews. Ideation, prototyping and concept testing will be evaluated through user feedback. The ideal outcome will be a functional interactive prototype.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.



The project consists of different phases.

1. Preparation: Things that need to be done (be)for(e) the Kick Off meeting
2. Analysis: The first weeks are meant to explore the context. Dive deeper into the context to find answers to the research questions proposed in the Problem definition.
3. Define: A clear design goal with the help of an interaction vision and a (first) list of requirements.
4. Ideation: Based on the analysis (2), first ideas are created. Small and simply ideas are combined to create a concept that can be tested.
5. Prototype/development: Simply mock-ups are created to test the effect during the test phases. Through an iterative process and rapid prototyping, the mock-up will gradually evolve in a decent prototype.
6. Writing: Working on the report will be done simultaneously during the previous steps. Biweekly reflection on the process helps me to stay on track.
7. Presentation: Working on the presentation happens before each milestone in the project.

Furthermore, an additional course 'Workshop: Climate Action In Kenya ' is taken as this aligns with my project and in the end will result in a positive contribution. Therefore, starting from week 38, the following eight weeks are only 4 days of work on my graduation.

Next, two weeks of holiday are taken in the planning: one right after the midterm and the second during the first week of the Christmas holidays.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, Stick to no more than five ambitions.

Over the years of my study, I often wondered who I wanted to be. Which direction do I want to pursue? Being a set designer is one of them. Having the opportunity to see how one is build up from the ground in Museon-Omniversum will help me discover if this would be my (future) dream job.

The course Interactive Technology Design (ITD) was one of my favourite courses. Rapid prototyping was an aspect I want to pursue during my graduation project. Receiving direct feedback and implementing them in short iteration cycles was fun and exciting. I believe that this approach also suits my project. It would be an accomplishment if the prototype would work without using 'wizarding of Oz'.

From the start, I knew that I wanted to design something for children. When searching for topics, I came across biomimicry which is relatively new to me. I have gotten easily immersed when doing preliminary research and I wanted to learn more about this principle. A museum would have been the perfect place to have such graduation project. Museon-Omniversum happened to start a new exhibition in this area.

During this project, I want to train asking question after having held (e.g.) an interview. I noticed that I often do not have questions at the end of a presentation. Furthermore, I want to practice substantiating my results better. In my study I sometimes had difficulties to get my point across clearly. At last, presenting for an audience has never been my strongest point. I just need to practice and practice. This is a personal learning goal I set myself in almost every course, slowly getting better. All in all, I just want to have fun during my final project; Itself will be a big learning opportunity.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Appendix B - Extra Research

Chapter 1 – Introduction to Biomimicry

Figure B1 shows different bio-inspired design methods, that aims to find effective solutions to the problems, we as species encounter, by looking at nature. Each method has their own approach which often leads to different but effective (sustainable) solutions or innovations. The overview shows the differences between various related terms. Before diving further into this topic, Bio-inspired design is the overarching name for all the 'Bio' names. Biomimicry uses biology as a resource to find sustainable solutions to societal and engineering problems. The focus lies in biological strategies. So, what isn't biomimicry?

“Biomimicry is one type of bioinspired design, but not all bioinspired design is biomimicry.
- Biomimicry Insitute, 2023”

Bio-Inspired design

Biomorphic

Bioinspired design methods aim to find effective solutions to the problems we encounter. Each strategy has its own approach, often leading to different but effective (sustainable) solutions or innovations.

Biophillicia

Humans are always searching for a connection to nature and life. Biophilia is concerned with how nature makes us feel. Thus, biophilic design lays the ground for connecting natural phenomena (patterns and forms (biomorphic)) in a modern built environment design. They are to reduce stress and enhance concentration due to their visual interest (Bernett, 2017).

Bio-utillisation

This term refers to the use of biological material in designs or innovations. An example is a living wall with a function: clean the air. Here, the use of the organism is used due to its characteristics. Another example is mycelium. It is already used for different purposes, such as packaging or insulation material .

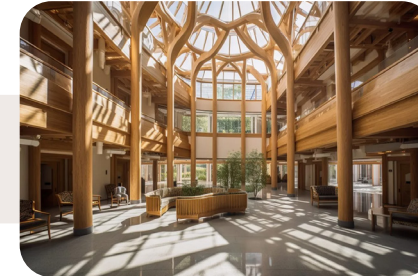
Bionics

Bionics focuses on the scientific translation of biological systems, leading to radical technological advancements that outperform current technologies to reach financial success (Wahl, 2017; L. Stevens, personal communication, November 6, 2023).

Biomimicry

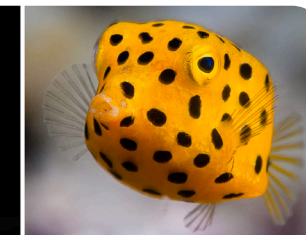
Biomimetic and biomimicry are used as synonyms in literature. Biomimicry derives its inspiration from biological principles and translates these to production and design. A philosophy that sees nature as a model that meets sustainable development challenges (social, environmental, and economic). However, themes such as 'Re-connection with' and 'Respect for Nature' are equally important in a biomimetic 'design process' (Biomimicry Institute, n.d.).

A cabinet made of marmer based on cells (Newson, 2013)



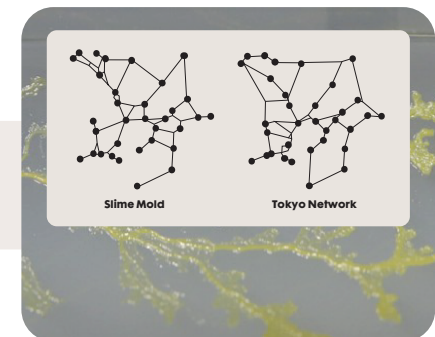
An AI generated room designed with biphilia principles in mind (Biophilic Architecture, n.d.)

Packaging for a bottle of wine made from mycelium (Mycobond, 2012)



An aerodynamic car based on the form of a boxfish (Bionincs and Biomimicry, n.d.)

Recreation of Tokyo public transport [right] network through slime mold [left] (Barnett, n.d.) & (Slime Mold Network Tokyo, 2014)



Line between these two fields is rather vague. Literature uses these terms interchangeably. The examples given below are often used in both fields. This also holds for this project.

Figure B1: Overview of bio-inspired design.

Chapter 2 – It’s time to ask nature

Humans were living in harmony with nature until the Industrial Revolution. This was the turning point where humankind slowly lost sight of nature, leaving the natural scale unbalanced. We started shaping the world to our liking. However, we, as species, can change! Biomimicry can help us. The word biomimicry is derived from Greek (Figure B2) and means to imitate life. Nature has evolved to be the best in its field and can lay the ground for fruitful innovation.



Figure B2: Quote about ‘why’ biomimicry is useful and the origin of the word ‘biomimicry’.

Chapter 2 –The core of biomimicry

This subsection delves into the essence of biomimicry and what it means. What can it mean for humanity?

The core of biomimicry consists of three pillars that are the essence of this discipline: Emulate, Ethos, and (Re)Connect (Figure B3).

These pillars are present in all its practices and are linked to why we should look at nature differently. Nature can be seen as:

- Nature as model addresses (Re)connect
- Nature as measure addresses Ethos
- Nature as mentor addresses Emulate

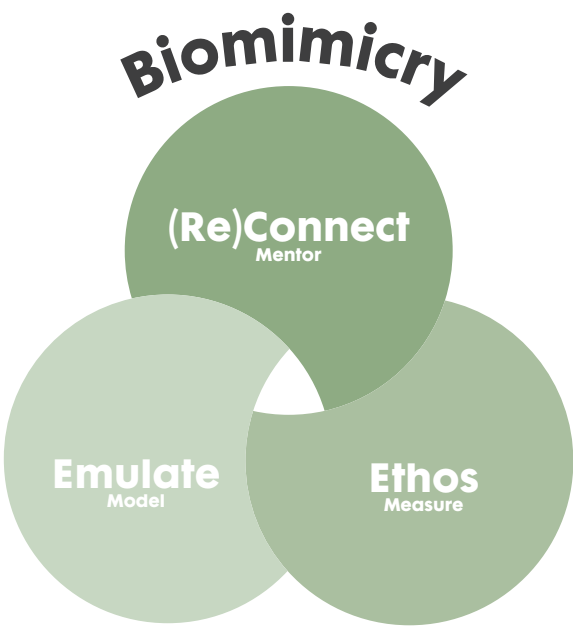


Figure B3: The three core essentials of biomimicry, linked to nature as ‘...’.

Nature as mentor

Knowing that everything is connected and humans are part of nature. Through practice and exploration, we try to strengthen our connection to nature through understanding (and restore what is lost).

Nature as measure

Ethos is the core of our intentions, our underlying philosophy to practice biomimicry. Respect, responsibility and gratitude to nature's capabilities are its ethics.

Nature as model

Learn by replicating forms, patterns, processes and ecosystems in nature to be able to incorporate them in innovative sustainable designs and solve human problems.

Chapter 2 – Nature as measure

As said before, materials are expensive in nature, and therefore, nature uses materials in closed loops. Waste does not exist in nature; Each organism on Earth contributes to its own ecosystem (Humans are species are the only ones that contradict this principle of nature); And all ecosystems are regenerative and withdraw energy from the sun (Biomimicry NL, 2013; Pawlyn, 2019)

The twenty-seven life’s principles of biomimicry (Figure B4).



Figure B4: The twenty-seven life’s principles derived by nature (Biomimicry 3.8,2023).

Chapter 2 – Nature as mentor

A short clip by AsapSCIENCE on YouTube about the evolution of life on Earth

“If comparing the evolution of life on Earth to a 24-hour clock ... humans only exist in the last minute (1.17 seconds before midnight). All recorded history of humankind fits within a few seconds. An individual life lasting barely an instant.”

We exploit the Earth each year, again and again, in an unsustainable way. This year only (2023), humankind went through Earth’s resources on August 2nd, marked as Earth overshoot day. This day means you surpass the point where the planet can regenerate the resources used in one year (Kluger, 2023). However, each country’s earth overshoot day differs (Figure B5). If all people live like us, people in the Netherlands, Overshoot Day would occur on April 12th. (Figure B5).



Figure B5: Figure about countries overshoot day, based on data taken in 2022 (Earth overshoot day, 2023).

Chapter 2 – Prerequisite to be Biomimicry

As mentioned in the introduction, the definition of biomimicry shifted more towards the ethical part plus reconnecting to nature became more important as the movement grew.

Based on information from Biomimicry 3.8 (2010) and Stevens (2021), current guidelines that biomimicry design practitioners and experts follow must contain the following elements. Complying with these guidelines makes a design solution that can be considered as part of biomimicry.

- 1) the solution must accurately emulate the chosen biological strategy or mechanism
- 2) it must have a sustainability win
- 3) it must mimic form, process, (eco)system, or one of Life’s Principles, with ecosystem being the highest level of biomimicry
- 4) it must be an inter-disciplinary effort, meaning that multiple fields work together to create a new solution. This can be a combination of all fields, e.g. biology and design, as well as economics and chemistry.
- 5) the solution must show gratitude and respect for the organism it was derived from

The three essential elements of biomimicry must all be involved in the process.

“All three are needed to call it biomimicry. Because, if you design something that seems to check all the boxes, but it is made by children’s hands in India or China, for example, you have totally missed the point.” (personal communication, L. Stevens, November 22, 2023)

Emulate (Prerequisite 1) -	Emulate is the mimicking as described above.
Ethos (Prerequisite 2) -	Ethos is the ethical design decisions you make as a designer.
(Re)connect (Prerequisite 5) -	Reconnect is understanding that we learn from the mentors in Nature and are grateful for this opportunity to learn the genius.

Chapter 2 – Reaching Visitors

Visitors motives

Based on a quantitative study by Sheng & Chen (2012), there are five types of experiences a visitor expects to have during their visit:

Easiness and fun

Visitors expect to experience positive feelings in a relaxed setting while being confronted with an exciting contrast or change by seeing new things.

Cultural entertainment

Visitors would like to be amazed by the exhibitions. They would like to be immersed in other cultures through stories or decor, e.g. through displaying physical objects.

Personal Identification

The visitor would like to relate to specific experiences or perspectives addressed in the museum, creating meaningful memories.

Historical reminiscences

[This often applies to historic museums] The visitors would like to feel or see the historic event as they envisioned, e.g., by displaying ‘the real’ objects in the museum.

Escapism

They expect to have their mind taken off their daily lives and want to be immersed in the museum exhibition.

Chapter 2 – Playful learning in a museum

To build further on characteristic 5 – social interaction, Lev Vygotsky, a developmental psychologist, states that children learn from each other. He called this ‘modelling’. The parents can contribute to the learning process by presenting information at a level the child(ren) understands. This is called ‘scaffolding’.

- 1. **Modelling** means imitating others. In a museum context, older children can inspire younger children through knowledge and/or skills. Meanwhile, younger children start ‘doing’ and explore along the way.
- 2. **Scaffolding** means making information comprehensible to children so that they can continue with the learning process by themselves. The parents change the knowledge level of the exhibit to the comprehension of the child. Present the information clearly so it is easy to ‘translate’ it to the child(ren) ‘s level. Showing how it’s done is one type of scaffolding (Mermelshtine, 2017).

An organisation based in London focuses on making museums more welcoming and engaging for children and families. This organisation, Kids in Museum (2022), has created a manifesto with the help of children to make every visit inclusive, engaging, accessible and welcoming for every family. Although some are more focused on the museum as an institution, steps 1,2 and 4 address how you can stimulate playful learning in a museum.

This manifesto consists of six steps

- 1. **Be welcoming**
Create environments where families can explore, have fun and learn through play together. Staff should interact with every member of the family. Information should be presented in such a way that everyone understands. Include artefacts in the exhibit that can be touched. Keep instructions positive.
- 2. **Be accessible to all**
Make the visit open to all. Families may have challenges when visiting the museum. This can be from cultural to economic barriers. Physically disabled visitors may experience barriers in accessibility, space, displays, etc. All-access information should be clearly posted online.
- 3. **Make it easy and comfortable**
Families are likely to stay longer if the spaces are family-friendly. Sell pocket money items in the museum shop, and have the café sell food for a reasonable price. Furthermore, there is a need for space for buggies, baby changing facilities, etc.
- 4. **Families come in all shapes and sizes**
Think of the things different families would need during their visit to be able to enjoy themselves together. Families are diverse. Reflect this in your displays, language, activities and ticketing.
- 5. **Communicate well**
Let families know what you have to offer as a museum. This can be done through posters, the website, or social media. Make pre-visit information easy to find online. Lastly, represent a diverse range of families in your marketing images.
- 6. **Be an active part of your community**
Young families want museums to address inequalities, support wellbeing and the (local) environment. Collaborate with your community on events, displays and exhibitions. This will help make the museum more relevant to the audience.

Chapter 2 – Transformative Learning

Chisolm et al. (2020) build on this by claiming that adults use (previous) experiences to create meaning for the things they encounter in the world. This means they would use a similar approach to past events to act in future situations. Unfamiliar events can, therefore, result in altering one’s understanding of the world due to the fact that adults have to (re)act to the situation with no prior knowledge, ergo the first step of transformative experience.

Awe moment

As said, the attention of the visitor has to be drawn in through provoking reactions and evoking strong emotions. These are the starting point of personally relevant insights and, in turn, lead to personal change in belief or self-perception (Vermeeren, 2023).

The moment of feeling ‘awa’ is linked in the brain to creating memorable experiences (and thus personal experience). An involvement of heightened senses is often accompanied by an ‘awe’ moment, which consists of a mixture of emotions.

“a multifaceted emotion of fear, combined with astonishment, admiration and wonder.” (Gaggioli, 2015).

They are often expressed through a pattern of facial movements (e.g. raising an eyebrow) and spoken words such as ‘wow’ (Monroy & Keltner, 2022). Next to this moment of feeling ‘awe’, there are also ‘a-ha’ experiences in which one comes to a new realisation or understanding. This happens during the previously explained ‘disorienting dilemma’.

These two expressions are not needed to create a transformative experience. Still, they should be strived for as they are linked to new experiences, thus contributing to the transformation process.

To increase the chances of creating a transformative experience, a museum can do a number of things, such as using triggers. Soren (2009) based these triggers on the personal experiences of his students. They are clustered and categorised to the following triggers, depicted in Figure B6. Although these triggers have not been peer-reviewed and tested by others, they provide a starting point for this project. For this project, the focus will be on the trigger: Authentic, Behavioural, Motivational, as they underpin the design goal.

Triggers for transformative experience	
Trigger	Description
Authentic	Seeing the authentic object, creating immersive spaces.
Behavioural	Using information to help the visitor see the world in a different light. Play on ‘a-ha’ moments to alter the visitor’s view and help them reach a new level of knowing
Cultural	Understanding changes in culture, through different medium which can lead to emblematic shift in the visitor.
Emotinal	Powerful experience that evoke emotions.
Motivantional	Through play or re-enactment, relive an expereince.
Traumatic	Showing (dreadful) sotries, schoking the visitor. This can be experienced through recreating context.
Unexpected	A schoking and unexpected suprise, which leaves the visitor impressed.
Sublime	An esthetic experience, challanging their imagination and reason. A pleasurable and frightening feeling at the same time (‘awa’ moment).
Being Witness	Showcase survivor’s personal objects to create empathy with one’s life lived.
Attitudinal	Shift in perspective through recreating settings or context, overwhelming visitors during their visit.

Figure B6: Triggers that may cause a transformative experience based on research by (Soren, 2009).

Appendix C - Analyse Museums

Appendix D - First exploration

The first exploration of finding 'problems and frustrations' within the target group. Responses are depicted, which are clustered in Figure D1.

Legenda

Museums visited

- Museum-Omniversum Den Haag
- Museum Volkenkunde Leiden
- Maritiem Museum Rotterdam
- Beeldtand & Oude Museum Rotterdam

Five senses and other categorisation

- F: Feel or do
- T: Taste
- H: Hear
- S: Smell
- V: View (see)
- A: Alone
- To: Together
- B: Both
- I: Informative
- P: Playful
- IM: Immersive

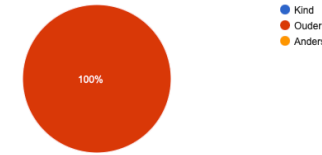
Analyse

Activity	Category	Senses	Other
1. Exercise to keep the movie running	Game-like approach to see a person ageing	F, H, V	A, I, P
2. Old-school video game		F, H, V	To, P
3. Game-like approach to see a person ageing		F, V, H	B, I
4. Balance game to check if you can hold on to enough energy		F, V	B
5. Building corner to adapt housing to certain landscapes		F, V	B, P
6. A quiz to compete to each other regarding SDG ???		F, V, H	To, I
7. A quiz about clothing where one can vote		F, V, H	B, I
8. A fishing game that relate to the 'lotter'		F, V	A, P
9. Mix of AR and Real world to work around the house		F, V	B, P
10. Vissen: Gode of Slechte dingen uit het water halen		F, V	A, P
11. Table football with information about the 17 SDGs		F, V	To, P
12. Sponse cards with statement about each SDG		F, V	A, I
13. A representation of a new room where they can replicate a recluse spot		F, V, H	B, P, IM
14. A digital cooking game that uses unusual ingredients (crickets etc.)		F, V	B, P
15. A digital quiz about Space		F, V	B, I
16. A wind 'tunnel' to let children experience the effect of form in regard to air resistance		F, H	B, P, IM
17. The elephant depicted as teacher.		H, V	B, I
18. The dung beetle as teacher. Activity: Roll a massive turd		F, V	B, P, IM
19. The polar bear as teacher. Activity: Walk as silently on ice as a polar bear		F, V, H	A, P, IM
20. The kangaroo as teacher. Activity: Jump as far as you can		F, H	B, I, IM
21. The crane as teacher. Activity: Can you dance as magically as them		F, V, H	B, P, IM
22. The armadillo as teacher. Activity: Colour a scale to camouflage		F, V	A, P
23. Collect stamps throughout the museum to fulfill the scavenger hunt		F	A, I
24. A question based quest outside the museum to discover characteristic of an animal.		F, V	B, I
25. An experience to visit boats or a lighthouse		F, V	B, I, IM
26. Learn different sailor mans knots		F, V	A, I, IM
27. At the end of the exhibit, the visitor could take home cards with 'device' that was linked to the exhibit		V	A, I
28. A choose-based game about immigration. Four choice affected the narrative		F, V, H	To, I
29. A fast-paced game that mimics the job of a port planner		F, V	B, P
30. A variation of the game "Who am I" and the characters are based on employees of the harbour		F, V	To, P
31. A mix & match game where you needed to match the map to the artefact		F, V	B, I
32. Game where you need to load the boat as evenly as possible. Each container was of different weight (which could be scanned for content)		F, V	B, P
33. A quiz based on the artifacts displayed next to it		F, V	B, I
34. A digital game to explore the benefits of taxation within the EU		F, V	A, P
35. A game for children about smuggling		F, V	To, P
36. A game about earning and spending money. Choices were recorded on a table. Activities had to be performed to earn money.		F, V, H	A, P
37. An immersive simulation about navigating a ship		F, V, H	B, P, IM
38. Visible stories were told about the taxes and tax evaders		V, H	A, I
39. An story based book on wood to discover how airport security works.		F, V	B, I
40. A video playing 'behind' eyes' to see how they work behind the desk at an airport		V	A, I, IM

Inspiration

Hier volgen enkele vragen over frustraties

Ik ben
8 antwoorden

 Kopieren

Wat gaat er goed binnen het gezin of mijn omgeving?
8 antwoorden

Samen eten (zonder mobiel aan tafel), naar bed brengen,

De omgang met elkaar als ouders met kinderen

Mijn kinderen hebben respect voor andere.

Het met elkaar praten

Behoud van harmonie onderling. Daarnaast ervaren de twee meiden genoeg ruimte om hun identiteit te vormen

We hebben regelmaat.

Veilige liefdevolle sfeer

Er is veel liefde.

Mijn grootste ergenis binnen het gezin of mijn omgeving is?

Teveel schermtijd, rotzooi in de kinderslaapkamers,

De omgang van de kinderen onderling (meiden van 9 en 10)

Mijn kinderen luisteren niet en stellen taken uit.

Dat er slecht word opgeruimd

Geluidshinder van buren of van kids na dagopvang

Dat er soms respect ontbreekt.

Zooi en rommel in huis

Veel huishoudelijk werk en altijd wel klusjes.

Waar loop ik tegen aan binnen het gezin of mijn omgeving?
8 antwoorden

Wanneer durf ik mijn kinderen zelfstandig het verkeer in sturen, wanneer laat ik 'wat' los,

Het uitdagen en opboxen tegen elkaar van de meiden

Het uitstel gedrag.

Eigenlijk niks

Op zoek naar een sport nu de oudste in groep 3 zit en veel minder kan spelen

Gedrags problematiek

Omgeving: onveilige verkeerssituaties

Te weinig tijd voor alles wat gedaan moet worden en voor elkaar.

Wat moet jij altijd doen waar je eigenlijk geen zin in hebt?

8 antwoorden

Afval wegbrengen, keuken opruimen, kleding naast mijn bed op orde houden

De strijd tussen de kinderen verhelpen

De rommel van de andere opruimen of iets 10Keer vragen

De was 😂

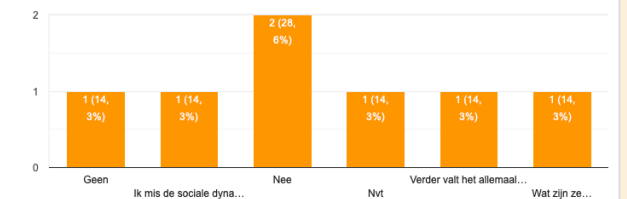
Nee zeggen

Het huishouden en vele hulpverlenings afspraken

Wassen en rommel opruimen

Huishouden

Nog andere dingen die je wilt delen over frustraties?
7 antwoorden



Kopieren

Hier volgen enkele vragen over zorgen

Waar maak ik mij totaal geen zorgen over?

7 antwoorden

De ontwikkeling van de kinderen zelf

De studie van me kinderen

Dat er genoeg te eten is.

Aansluiting bij leeftijdsgenoten

Dst mijn kinderen genoeg liefde krijgen en dst ze niet verzorgt worden

Geld

Ik denk dat we het praktisch en financieel altijd wel zullen redden als gezin.

Mijn grootste zorg binnen het gezin of mijn omgeving is?

7 antwoorden

Nogmaals de omgang van de kinderen onderling

De toekomst en uitzicht op een eigen huis. Voor de kinderen

Hoe anderen omgaan met de adhd van de kinderen

Rust vinden om te leren bij de meiden, ergens op durven blijven oefenen voordat iets af is. Fouten maken hoort er bij, neem de tijd om op 1 ding te focussen

De gedragsproblematiek.

Dat we allemaal gezond blijven

Hoe onze kinderen een toekomst op kunnen bouwen (terugtrekkende overheid, woningnood enz.).

Waar maak ik mij nog meer zorgen over binnen het gezin of mijn omgeving?

7 antwoorden

Weinig

Of er wat aan het huizen te kort word gedaan

Geen

Kan ik blijven voorzien in voldoende en biologisch voedsel

De wereld waarin mijn kinderen later leven

Klimaatverandering

Verhardende maatschappij



Nog andere dingen die je wilt delen over zorgen?

6 antwoorden

De Covid aanpak had niet ge...

Geen

Nee

Nee eigenlijk niet

Nvt

Figure D1: Clustering of the responses from envelope among the target group to find 'problems and frustrations'.

Appendix E - Design User Test 1

The user test set-up, plus the material used in the user test (Figure E1 & E2) is depicted below. The iterations between setting B - Design Along! are depicted in Table E1.

Testplan 1

Inleiding:

De eerste testfase, die plaats zal vinden in de herfstvakantie, zal vooral gericht zijn op de exploreer-fase. De test zal plaatsvinden in het Museon-Omniversum, zodat het met museumbezoekers getest kan worden. Dit zal bijdragen aan het afbaken van mijn project voor mijn afstuderen.

Waarom/Onderzoeksdoel:

Ik mijn verdere keuze in het project baseren op de uitkomst van de volgende testjes. Kun je bezoekers iets meegeven over biomimicry, als je een herkenbaar ‘probleem’ waarin zij zichzelf herkennen, gebruikt om een biomimicry principe/innovatie uit te leggen. De andere mogelijkheid is dat ik beslis om na deze test verder te gaan op een biomimicry verschijnsel en dan op dat idee verschillende tentoonstelling mogelijkheden genereer. Tevens wil ik aan de hand van drie verschillende testjes achterhalen wat wel/niet werkt qua aanpak voor bezoekers.

Onderzoeksvragen:

- Wat weten de bezoekers al over biomimicry?
- Hoe zouden de bezoekers dit willen ervaren?
- Hoe vindingrijk zijn de bezoekers?

Waar

De entreehal, op het One Planet Now! Plein. Deze ruimte is ongeveer 100 m2 minus de ‘trap’ en tekentafel die er op dit moment staat, zie blauwe stip. Dit is op de begane grond van Museon-Omniversum.

Ik wil een opstelling creëren zoals in de figuur hieronder, één tafel met twee whiteboard. Nummers corresponderen met de testjes.

Wanneer

Week van 16 oktober tot 22 oktober

Opzet:

Bij deze test gaat het vooral om kwalitatief onderzoek. Mijn doelstelling is om tenminste 20 personen te benaderen. Hieronder volgt de opzet per onderzoeksvraag **Fenomeen herkennen en sensitizing**
1. Een bord met klittenband waarop de vraag staat ‘Hoe kan de natuur ons helpen?’. Ik leg uit aan de hand van het voorbeeld, klittenband, uit wat het is. Vervolgens vraag ik of zij al voorbeelden weten. Die kunnen ze dan op whiteboard bordjes tekenen. Hieruit leidt (hopelijk) ook een gesprek.

Hoeveel participanten tegelijkertijd
Een gezin of max 4 personen tegelijkertijd
Verwachte tijd
5 min maximaal per familie
Verwachte aantal participanten
20 bezoekers
Aandacht trekken
Kleur gebruik, open houding door researcher, gespreksstarters

Materiaal

- Flipover
- 3 Klittenbandbordjes
- Whiteboards met klittenband erachter
- Whiteboard markers
- Schoonmaakdoekje
- Tafel voor de kinderen om aan te zitten
- Klittenbandballetjes

Mix & Match en sensitizing (Q1, Q3)

2. Hierbij ligt er een twintigtal kaarten. Tien kaarten beelden dieren of planten af. De andere tien kaarten beelden innovaties af die zijn ontworpen op basis van biomimicry. De bezoeker moet ze aan elkaar linken. Op de achterkant van de kaartjes staat nog wat extra informatie, mocht daar interesse voor zijn. Vervolgens wil ik tijdens het gesprek achterhalen hoe zij dit zouden willen ervaren.

Welke aspecten van dit ontwerp vinden zij leuk?

Waar (hoeveel ruimte)

Aan dezelfde tafel/plek waar de eerste test plaatsvindt
Hoeveel participanten tegelijkertijd
Een gezin tezamen of max 2 personen tegelijkertijd
Verwachte tijd
Mix & Match max 5 min. Als ze de informatie willen lezen op de achterkant, 10 min
Verwachte participanten
20 bezoekers
Aandacht trekken
Kleurrijke kaartjes; Open houden van researcher; Vragen stellen over biomimicry; Wat zouden ze willen zien?; Hoe zouden zij dat willen zien?;

Materiaal

- Tiental dierenkaartjes
- Tiental (innovatie) biomimicry kaartjes
- Gekleurde draadjes
- Houten achter-bord
- Blokje om antwoorden te verbergen
- Klittenband

Ontwerpen

3. Tijdens mijn onderzoek naar biomimicry, kwam ik erachter dat de voornaamste voorbeelden helemaal niet zo recent zijn. Daarnaast speelde de gedachte over een transformative experience door mijn hoofd. In een korte enquête ben ik opzoek gegaan naar ‘problemen’ binnen het gezin, in de breedste zin van het woord. Voor mijn eindproject zou er dan een stelling/probleem worden gegeven. Vervolgens laat de expositie ernaast zien hoe de natuur het oplost. In deze opstelling wil ik een tekstwolkje plaatsen met daaronder een 15tal kaarten met dieren of planten. Op de achterkant van de kaarten wordt in steekwoorden enkele eigenschappen van het desbetreffende organisme opgenoemd. Aan de bezoekers wordt gevraagd hoe de natuur deze stelling op zou lossen met behulp van de kaarten. Ben benieuwd hoe vindingrijk zij zijn in het leggen van een connectie tussen het probleem en biomimicry.

Waar (hoeveel ruimte)

Bij dezelfde tafel/plek waar de eerste twee tests plaatsvinden, liefst aan de muur
Hoeveel participanten tegelijkertijd
Een gezin of maximaal 4 bezoekers
Verwachte tijd
10 min
Verwachte participanten
20 bezoekers
Aandacht trekken
Relevante uitroep dat de aandacht trekt, kleurrijke kaarten
Materiaal

- Twintigtal kaarten met dieren erop die ‘betrokken zijn’ in biomimicry
- Kaartjes van papier (en 1 whiteboard) waarop mensen reacties kunnen achterlaten
- 10 pennen
- Klittenband
- Een ‘tekstwolkjes’ met
- Hoe hou ik mijn kamer schoon?

4. Flipover met verschillende stellingen zoals:

“

- Hoe kan ik beter/leuker spelen?
- Hoe kan ik mijn kamer sneller opruimen?
- Hoe kan ik sneller zwemmen?
- Hoe kan ik zo snel van A naar B?
- Hoe kan ik een groep in beweging krijgen?
- Hoe blijft ik / mijn huis koel?

”

Waarop mensen aan de hand van stickers (zie afbeelding) kunnen stemmen welk ‘probleem’ zij graag opgelost zouden zien willen worden, a.d.h.v. biomimicry
Ook liggen er kaartjes waarop bezoekers hun dagelijkse onhandigheden/ergernisjes kunnen opschrijven en achterlaten

Benodigdheden

- o 10 pennen
- o Kleurstickers (zie afbeelding)
- o Whiteboard/Flipover
- o 50 Kaartjes voor reacties

Documentatie

Voor documentatie wil ik

- Foto’s maken van hun getekende antwoorden
- Notities maken
- Observeren hoe ze te werk gaan
- Foto’s maken van werk en het bezig zijn
- (Anonieme) quotes gebruiken

Data-analyse

Foto’s en quotes wil ik gaan gebruiken om mijn documentatie te versterken en onderbouwen
Observaties zullen gebruikt worden om te ontdekken wat bezoekers al weten, evenals welke aanpak wel/niet werkt in een museum.

Table E1: Iterations between pilot test and in between test days..

Setting	Pilot test	 Iteration 1
A - Mix & Match	-	-
B - Design along!	The chalkboards were removed and only 8 organism cards are presented at the time.	Clarifying instruction sheet; Putting a title on top, together with ‘Design along!’ and ‘The characteristic of this animal helps ...’; integrate interaction
C - Vote!	-	-
Overall	No clear walking route at ground floor Museon-Omniversum. Chronological order cannot be maintained.	-

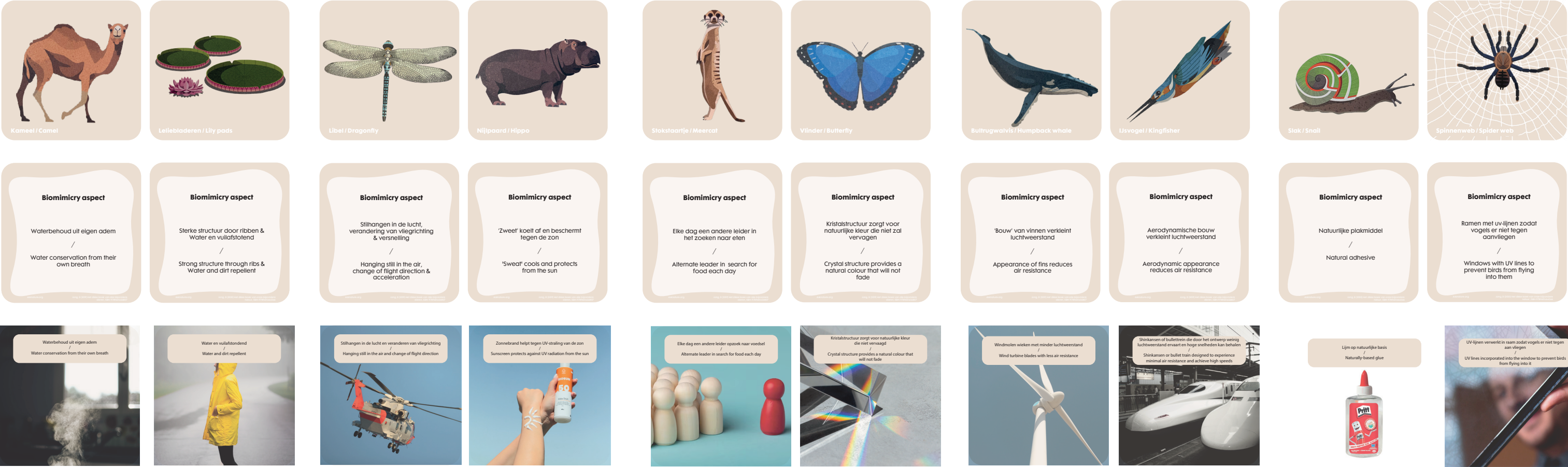


Figure E1: Crards for setting A – Mix & Match.

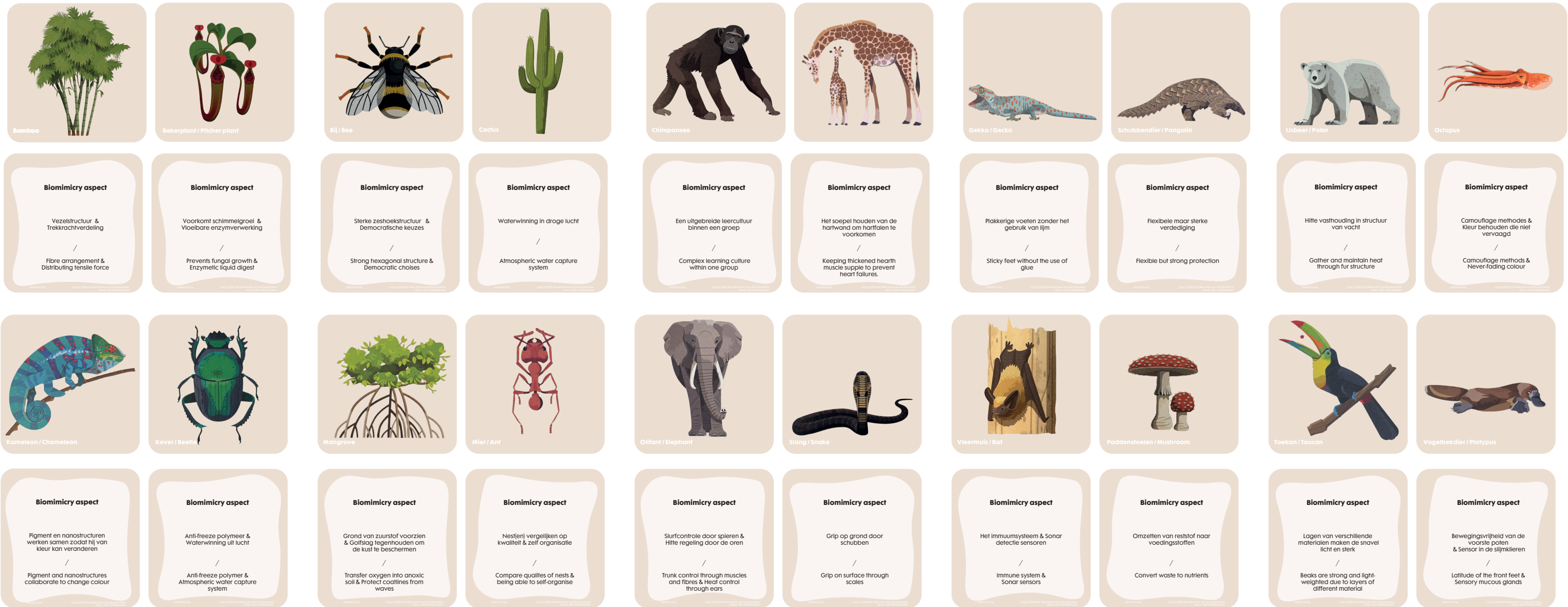


Figure E2: Cards for setting B – Vote!

Appendix F - 'Problem Approach' primary school

The material used for the session at the primary school (Figure F1 & F2) + the analysis of the responses (Figure F3).

WAT VIND JIJ BELANGRIJK?

HULPVRAGEN: WAT DOE JE GRAAG? WAAR HAAL JIJ PLEZIER UIT? WAAR GEEF JIJ OM?

Figure F1: Front side of the form the pupils had to fill in. Worked as sensetising into the right direction.

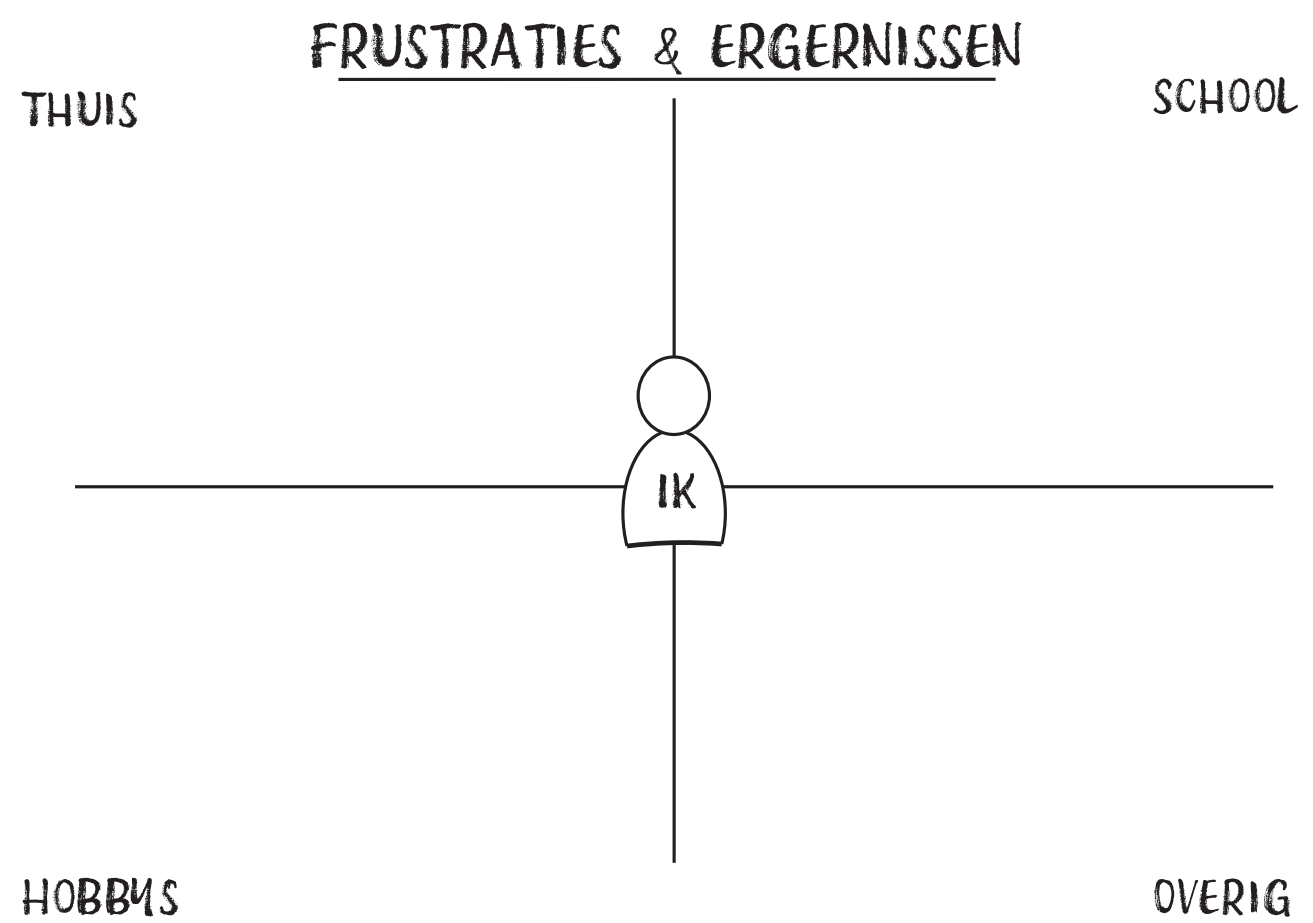
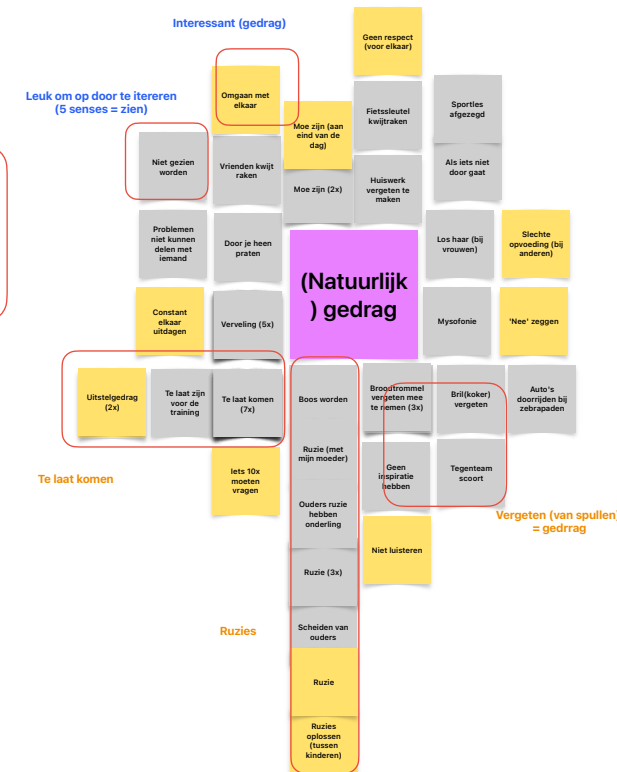
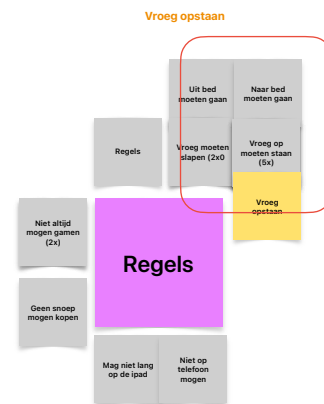
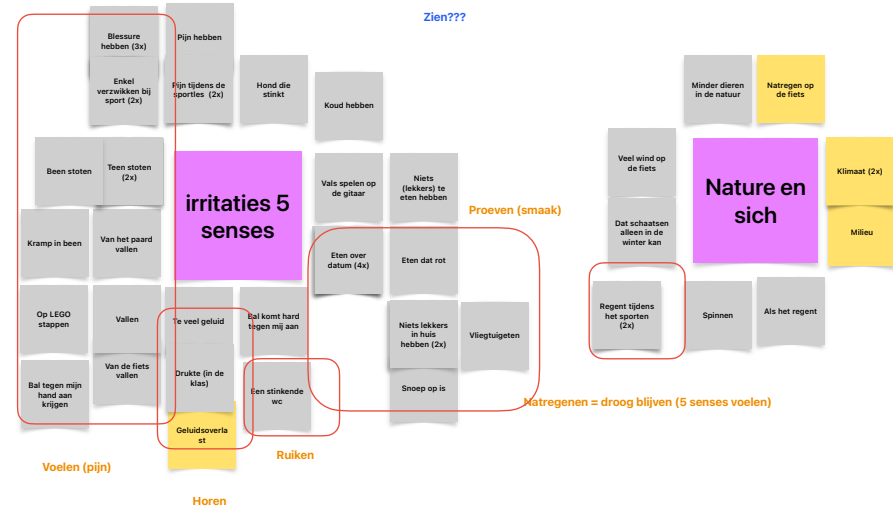
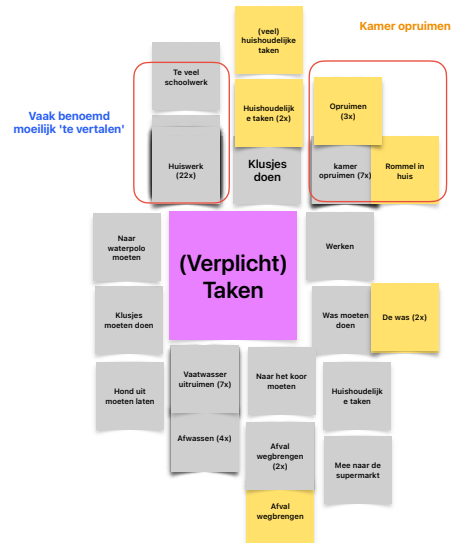
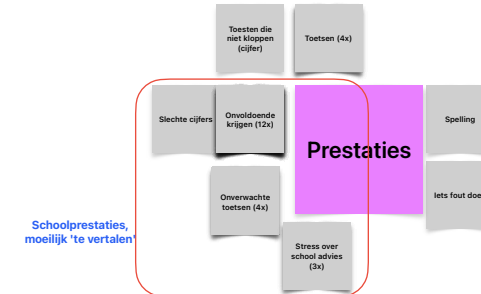
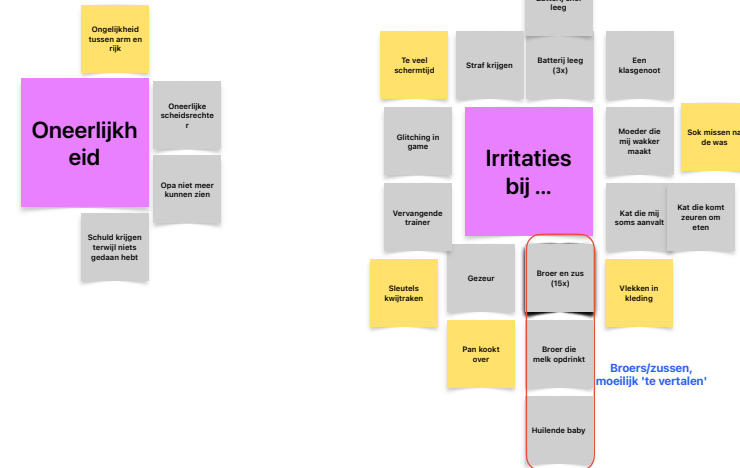
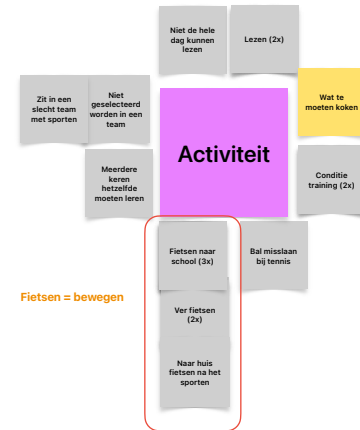


Figure F2: Back side of the form the pupils had to fill in. This side was used to get the data sought after.

```
graph LR; Parents[Parents] --> Ontdekken[Area om te ontdekken]; Children[Children] --> Ontdekken; Ontdekken --> Kopjes[Opvallende kopjes]; Kopjes --> Notities[Notities];
```



Appendix G - Findings User Test 1

General findings are categorised under different headings

Knowledge

- The term is unknown by most, although many people now the basic examples.
 - All visitors that I spoke with are excited to learn (more) about biomimicry.
- However, the term is difficult to understand for children.
- Some visitors are interested in the information. ‘Why are this innovation & animal are connected?’. Information needs to be present for visitors.
- However, many visitors do not read the information about biomimicry
- Extra information has to be given by the researcher before visitors understand the topic.
 - A board with information should be present, but at the same time, they don’t look further than the test they are standing in front of.
 - Term ‘biomimicry’ is too difficult to understand. I need to rephrase it or use a synonym

Characteristics of the visitor

- (Grand)parents are open to talk. Often let the child discover on their own and help when needed. They involve children into the conversation.
- When the researcher asks something, they leave room for the children to answer.
- Getting an answer from them results in repeating the question directly at them
 - Children are more difficult to approach
 - Sometimes visitors are hesitant to give answers (even though it is mentioned that there is no good or wrong)

- Children easily know answers at ‘design along’ test, parents do have more trouble making connections with the organisms while solving the problem.
 - (Grand)parents first read the assignment, children start right away
- Observations
- Children run around the museum (explorer), their parents trotting behind and being the facilitator (or often just on their phone).
 - Some parent are only busy with keeping their children close and prevent them from running away.
 - Nobody reads the back of cards, while the information is printed on that side (and mentioned in the steps).
 - Drawing or writing just doesn’t work in museum contexts. Children are distracted by this and do not follow the test anymore.
 - Some visitors do read the steps for the test but do not carry them out.
 - Visitors are curious about what is presented, but at the same time, if the prototype is not ‘catching’ enough, other pieces in the museum draw the attention away.
 - If people don’t understand the function/goal of the exhibition, they will walk on.
 - The situation ‘Hey! Tidy up your room!’ is preferred by parents and siblings. The person in question is always claiming “That is not true!”.
 - No direct walking route can be determined on the ground floor (they differ too much per visitor). Beforehand one cannot say which test would be approached first.
 - Do not number different tasks as this can cause confusion in approaches, as there is no direct walking route on ground floor.

Product

- Interactive products work best (mix&match compared to design along and voting)
- Make text on cards more easy to understand (A2 niveau), this text should be simple and short
- Visitors do not read the information about biomimicry.
- ‘Doing’ over ‘reading’. ‘Doing’ works best. Let them experience.
- The test has to be understood quite fast (simplistic as possible)
- Mis-use will happen. Even in this prototype, things are taken apart that are not needed.
- Everything that can be removed, will be removed.
- Visitors dismantle prototype in absence of researcher (during break)
- Regular checks if everything still is ok is needed if the prototype/test is left alone.
- Test 1.3 works best in a workshop setting, where there is room for conversations and discussions.
- ‘Voting’ test is a well working way of passive testing
- Use of consent-forms just does not work. Visitors do not want to read the form before interacting with the test product. It weakens their attention to the test product. If asked afterwards, they do not bother to sign and often say that it is fine.

Take-aways

- Simple word use is needed to describe the difficult topic: biomimicry. Information should be present, but not too long.
 - The product (‘s use) needs to be clear instantly. Little to no explanation is needed to understand the exhibition.
 - The goal of the test has to be simple and give a ‘positively rewarding feeling’.
- TIP: think beforehand what answers you would like to receive should be taken to heart. One part of the goal is not fully met (would they like this approach). ‘Design along’ goal of this test is not always clear to parents.
- Make the product stand out and attractive to attract attention towards the design.
- ‘Doing’ over ‘reading’. ‘Doing’ works best. Let them experience.
- Placing of prototype influences what draws attention. Also walking order in the museum influences which prototype they see first.

Appendix H - Brainstorm Sessions

Brainsstrom material (Figure H1) that led to ideas to explore (Figure H2).



Figure H1: Brainstorm material from brainstorm sessions with IDE alumni and students.



Figure H2: The brainstorm session led to few ideas depicted in this Figure.

Appendix I - Design User Test 2

Testplan 2

Inleiding:
Deze testperiode zal plaatsvinden in de tweede week van de kerstvakantie (2 – 6 januari). Deze fase zal gericht zijn op ‘deeper understanding’ en ‘explore’ fase van het transformative learning experience process. De test zal plaatsvinden in Museon-Omniversum, zodat het getest kan worden met bezoekers: families met kinderen vanaf 8 jaar (schatting). De resultaten zal bijdragen aan het verfijnen van het concept.

Onderzoeksdoel:
Het doel van dit onderzoek is het ontwikkelen van een effectieve strategie voor het starten van een dialoog tussen families over biomimicry, aan de hand van interactieve activiteiten. Verder moet de houdingen en percepties van gezinnen in relatie tot biomimicry in kaart gebracht worden. Draagt het prototype bij aan het (vergroten) van kennis van biomimicry binnen gezinnen?

- Onderzoeksvragen:**
1. To what extent do visitors recall what they have learned (about biomimicry) after interacting with the prototype?
 2. How do visitors reflect on biomimicry through their own participation and discussions among families?
 3. How do visitors perceive the interactive experience of the prototype?

Locatie
De test zal dit keer op de eerste verdieping van Museon-Omniversum plaatsvinden, om te voorkomen dat de zone ‘Sport & Bewegen’ de aandacht afleidt. Voornamelijk bij kinderen. Het prototype komt te staan bij SDG 13 – klimaatactie, 14 – Leven in water en 15 – Leven op het land, in de buurt.
Opzet:
De test setup wordt op een witte tafel neergezet. Geen instructie zal worden gegeven aan de bezoekers. Ze moeten de interactie zelf ontdekken.
Poster met verdiepende informatie over biomimicry, vooral gericht op wat ouder publiek. Ouders zouden misschien moeten helpen om de vertaalslag te maken naar kinderen.

- Materiaal:**
- A. Beeldscherm voor digitaal prototype
 - B. Laptop dat digitaal prototype runt
 - C. Extern bluetooth toetsenbord
 - D. NFC reader
 - E. Twee probleem – activatie blokken
 - F. Twee dier – activatie blokken

- Methode:**
Kwantitatief:
- o Observeren:
 - Turven welk aanpak vaker wordt uitgevoerd (vanuit Dier of vanuit Probleem).
 - Turven of ze vaker kiezen voor probleem oplossen in huis of innovatie gelinkt aan dier.
 - o Evaluatie-formulier/eind enquête bezoeker
 - Vanuit startpunt Dier
 - Vanuit startpunt Probleem
 - Welke aanpak prefereer jij?
 - Overkomt dit probleem jou ook wel eens?
- Kwalitatief:**
- o Observeren:
 - Begrijpen bezoekers hoe de installatie werkt (interactie)? Weten ze wat ze scannen.
 - Leidt de installatie tot een gesprek bij bezoekers?
 - Begrijpen ze de animaties?
 - o Interview:
 - Wat hebben jullie geleerd vandaag?
 - Kunnen jullie uitleggen wat biomimicry is?
 - Kan jij je inleven in het probleem?
 - Als je een probleem hebt wat je op moet lossen, waar ga je zoeken naar oplossen? Zul je nu sneller naar de natuur kijken voor oplossingen?
 - Begrijpen jullie de animaties?

- Evaluatie vragen:**
1. In hoeverre worden bezoekers gestimuleerd in self-reflectie? (probleem-in-huis)
 - a. Snappen zij het verband tussen het organisme en het probleem/innovatie?
 2. In hoeverre doorlopen bezoekers het hele riedeltje? (heel block schema)
 - a. Wordt het een boven de ander geprefereerd? (Dier/Probleem)
 3. In hoeverre leidt de installatie tot het voeren van een gesprek over biomimicry binnen families?
 - a. Nemen ouders de rol aan van facilitator? Of zelf ook explorer?
 4. Welke (sociale) interacties vinden er plaatst bij het prototype?
 - a. Hoe wordt het prototype ervaren?

- Documentatie:**
- Foto's
 - Notities maken
 - Anoniem quoteren
 - Observatie

Data-analyse:
Foto's en quotes wil ik gaan gebruiken om mijn documentatie te versterken en onderbouwen. Observaties zullen gebruikt worden om te ontdekken welke aanpak bezoekers prefereren en of ze de installatie begrijpen. Het evaluatieformulier zal inzicht geven in de voortgang ‘deeper understanding’ fase.

Decision tree of the two approaches

Organism-approach (Figure I1) and Event-Approach (Figure I2).

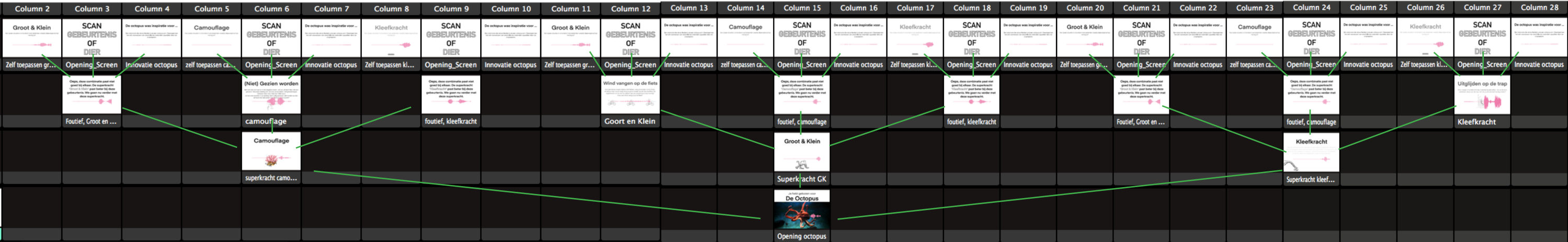


Figure I1: The decision tree for the organism-approach. De lower level is the start, with each higher level having three options. The green lines depict each option.

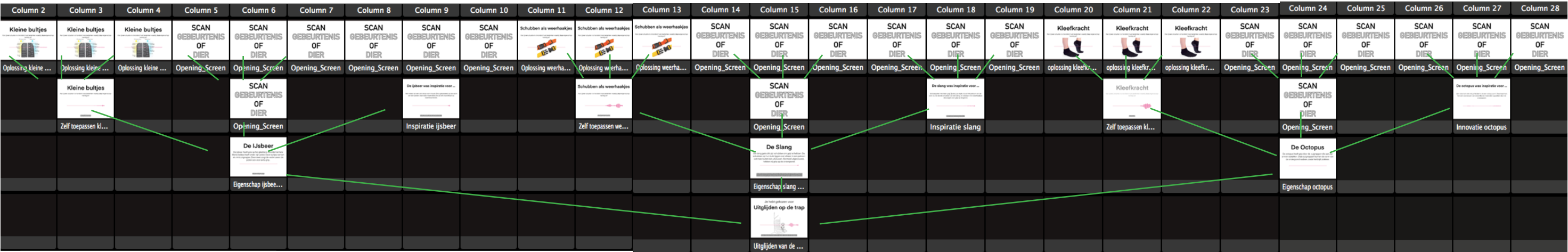


Figure I2: The decision tree for the organism-approach. De lower level is the start, with each higher level having three options. The green lines depict each option.

Appendix J - Findings User Test 2

Testdag 1

Testpersonen: 22 bezoekers (een familie telt ook als een bezoeker)

Grofweg geturfd, maar keuze tussen begin dier en probleem is grotendeels gelijk.

Observatie

- Biomimicry is niet duidelijk, mensen onthouden het woord niet.
- Meeste mensen kijken heel serieus tijdens het luisteren
- Ouders helpen met keuze, sommige gaan op ooghoogte staan.
- Jonge kinderen zijn afgeleid door de scan blokjes en spelen meer daar mee
- Sommige kinderen drukken al eerder op de knop, terwijl het filmpje nog bezig is. (voor deze setup onhandig omdat geluid door elkaar heen gaat spelen)
- 2 kinderen dachten dat het scherm touch screen was ipv fysieke buttons

- Niet altijd duidelijk wat je moet scannan.
- Gesprek onderling, bij zelf biomimicry toepassen gebeurt weining. Veel mensen wachten tot er een antwoord verschijnt. 6 bezoekers gingen wel onderling overleggen. Als ik de vraag herhaal, komt het gesprek wel opgang tussen kind en mij.
- Bordjes worden niet gelezen
- De kinderen die met ouders gesprek aangingen konden wel samen op een idee komen, terwijl als ik het vroeg wist niemand (op 1 na) ene idee.
- Het woord biomimicry blijft moeilijk voor kinderen.
- Het woord superkracht is niet zo uitnodigend als dat ik dacht.
- Mensen kijken meer naar het computerscherm dan dat ze de borden aan de zijkant lezen met wat ze kunnen kiezen. (14/22)
- Iedereen zit de hele flow uit en bekijken de hele video's.
- Ouders bij jongere kinderen, de keuze opties herhalen en samen bespreken of het wel of niet past.
- 2 Ouders herhaalden maar het woord 'biomimicry'. Kinderen onthouden meer de eigenschappen van een dier dan het woord.

Vragen achteraf:

- Filmpjes waren niet te lang of te kort.
- Als gevraagd wat ze geleerd hebben, wat de octopus kan. "Ik heb geleerd wat de octopus kan. Dat hij zuignappen heeft en kan veranderen van kleur" – kind (schatting 7 jaar)
- Na het zien van oplossing niet van de trapp glijden ouder: "Oh, dat herken je wel toch? Sokken met nopjes?" Kind: "Ja, die heb ik ook."
- Zelf bedenken vna de trap glijden. Kind – "Is dat zoals bij een douchemat?" Ouder – "Oh, ja. Slim. Daar had ik nog niet aan gedacht."
- Camouflage zelf oplossing "dan kan ik mijn snoepgoed verbergen" ... toen werd antwoord zichtbaar Ouder" hey, dat zei je net. Denk ik dat jullie met lego zitten te spelen, maar zitten jullie gewoon te snoepen". Broertje "Oh, net lego steentjes."
- Iedereen vind het stemmen heel leuk, en leert wat van de octopus (dus niet perse biomimicry).
- Ouder waarvan kind weg was "Informatie is speels overgebracht. Neemt de tijd om alles uit te leggen in een rustig tempo. Ik vond het leuk genoeg om alle informatie te ontdekken"
- Zien van bestaande innovatie octopus. Ouders" Dus als een iemand een arm wil waarmee ze dingen kunnen oppakken..." (kind schreeuwt enthousiasst) "Zoals een octopus"

Verbeteringen

- Het filmpje gaat te snel door na de vraag: 'Herken je dit ...?', maar 5 bezoekers herhaalde de vraag naar het kind.
- Meer kleur in de filmpjes.
- 1 bezoeker vond de filmpjes te lang
- Wordt maar een keer gespeeld (of dier of gebeurtenis), niet beide. Kan komen doordat er maar twee opties zijn.

Conclusie/assumptie:

Kinderen willen gewoon doen.

Testdag 2

5-1, 15 bezoekers en 1 museum expert

Observatie

- Bordjes worden amper gelezen
- Bezoekers staan lang te kijken wat te moten doen. Snappen het niet. Ik begin vaak met de vraag of ze snappen wat je meot doen. Ik vul aan met informatie wat te doen. Als ik zeg dat ze het mogen scannen, zetten ze het naast de doos of op de knoppen. Vaak, maar niet altijd, helpt de ouder. Maar ook die snappen het soms niet waar het gescand moet worden. (12/15)
- Kind (2 bezoekers) kijken halverwege de flow wel weg, maar blijven wel staan bij de installatie.
- Niet elke bezoeker ziet de wegwijzer over biomimicry. Veel trekken gelijk naar het scherm toe (9/15).
- Bezoeker vraag aan mij of hij nu wat moet verzinnen met die superkracht. Praat onderling niet met de ouder. Echter, vandaag (8/15) begonnen wel onderling een gesprek met ouder/kind.
- Meeste ouders spelen facilitator. Ouders helpen wel met uitleggen van maken van keuzes en wat te drukken (vooral bij wat jongere kinderen), maar gaan vervolgens niet overleggen voor een mogelijke oplossing van biomimicry in huis met de eigenschap (3/15)
- (slang -> weerhaken), kind: 'Dat is handig bij de zwembadrand, zodat je niet uitglijdt'.
- Verdeling begin probleem/dier = 9/6.
- Veel bezoekers kiezen toch voor zelf biomimicry verzinnen in en rond om huis over bestaande ontdekken (11/4)

Interview

- Ik vroeg 'Biomimicry, weet je nog wat dat is?' kind: 'nee'. Ik: "wat heb je net geleerd?", kind' over de octopus, wat het kan'. Ik leg nog eens uit wat biomimicry is en vraag 'Willen jullie hier nog meer over leren?' Kind 'JAAA'.
- Bij zelf bedenken (kleefkracht). Kind: 'Handig als je een spinnenweb weg moet halen, kan je er naar toe klimmen en hoeft je geen ladder te pakken'.

- Deze bezoeker vond de filmpjes net te lang duren
- Als ik vroeg waar het over ging. Kind: 'Het ging over biomimicry en hoe we dat kunnen gebruiken om een probleem op te lossen.' (schatting 12/13 jaar oud)
- Als ik vroeg waar het over ging. Kind: 'Ja, dat je kan leren van de natuur en dat kan toepassen voor het vinden van oplossing.' (schatting 10 jaar)
- Ouder zei: "Ja, ik vind het belangrijk dat mensen beseffen dat er veel te vinden is in de natuur. Goed dat het museum dit onderwerp wil aankaarten." Observatie: het kind liep wel weg toen hij klaar was met de installatie en wilde geen gesprek voeren. Kwam ook niet zelf met een oplossing voor in huis met superkracht.
- Toen ik vroeg, weet je nog waar het over ging, gaf kind antwoord dat je kon leren van de natuur door het na te doen. Dus ik zei, dat is precies wat biomimicry is. Ouder naar kind: 'Weet je waar nadoen in het Engels is?' kind: 'Ja, mimic.' En je zag dat het kwartje viel
- Kind: 'Ja dat moeilijke woord. (kijkt naar de wegwijzer) Bio...mimicry.' De kinderen liepen later weg, maar de ouders gingen het gesprek aan en zeiden 'Oh, net als die lijm beneden, gebaseerd op de gekko?' ik: 'Ja, precies' en ging uitleggen over bullettrain en klittenband. Dat je beide kanten op kan werken (vanuit oplossing of vanuit dier).
- Kind had eigenlijk niets geleerd want wist al over de camouflage van de octopus. (1/15) die niet iets nieuws had geleerd.

Expert museum

- Het zou logischer zijn als je dier -> innovatie -> zelf toepassen. Dan leg je de link. (begon hier met probleem)
- Niet eindigen met 'hier komt een oplossing' maar met 'hier komt een voorbeeld' (bij zelf biomimicry toepassen)
- Misschien aan het einde eindigen met 'Wil je nog meer ontdekken van andere dieren/gebeurtenissen?'
- Vond het heel leuk dat je kan scannen en keuze hebben
- Prefereerde vanuit het probleem

Tips

- Kan de gebeurtenis ook visualiseren op het scan-blokje.
- Precieze inkeping waar het scan-blokje in moet
- Leuk met veel opties

Appendix K - Design User Test 3 Museon-Omniversum

This appendix explains the first try of user test 3 in Museon-Omniversum. First, the testplan is addressed, followed by the explanation of the concept. It concludes with findings, which are inconclusive, and ends with a discussion.

Testplan 3

Inleiding:

Deze testperiode zal plaatsvinden in de het laatste weekend van januari (27 – 28 januari). Deze fase zal gericht zijn op het achterhalen van het design goal. De test zal plaatsvinden in Museon-Omniversum, zodat het getest kan worden met bezoekers: families met kinderen vanaf 8 jaar.

De design goal is

Design a playful and interactive exhibition...

1. Make the visitor aware of what biomimicry is and can do.

2. Encourage dialogue between families to stimulate self-reflection and deeper understanding of biomimicry by presenting information invitingly.

3. Interacts playful with the concept ‘biomimicry’ through solving ‘problems and irritations’ through simplified steps taken from Biomimicry Thinking.

4. Plant a seed for future problem-solving (to use biomimicry).

or families with children (8 years and up) to explore biomimicry and let them understand the usefulness of biomimicry for future problem-solving for the coming ‘biomimicry zone’ at Museon-Omniversum.

Onderzoeksdoel:

Het doel van dit onderzoek is om te achterhalen of het design goal, zoals hierboven beschreven, wordt behaald met de installatie.

Onderzoeksvragen:

Prototype

1. what do visitors recall about mimicry after interacting with the prototype?
2. Are visitors stimulated to discover multiple animals/solutions?

Intention

3. What kind of social interaction does the exhibit evoke?
 1. To what extent do visitors reflect on biomimicry through their own participation and discussions among families?
 2. To what extent do they expect to refer to biomimicry in future scenarios?

Usability

4. How do visitors perceive the interactive experience of the prototype?
 1. Do the visitors understand the flow of the prototype?

Locatie

De test zal op de eerste verdieping van Museon-Omniversum plaatsvinden, om te voorkomen dat de zone ‘Sport & Bewegen’ de aandacht afleidt. Voornamelijk bij kinderen. Het prototype komt te staan bij SDG 13 – klimaatactie, 14 – Leven in water en 15 – Leven op het land, in de buurt

Opzet:

De test setup wordt op een witte tafel neergezet. Geen instructie zal worden gegeven aan de bezoekers. Ze moeten de interactie zelf ontdekken. Rondom het beelscherm worden borden geplaatst wat in het kort uitlegt wat Biomimicry is. De gebeurtenissen ‘Natte sokken hebben, van de trap glijden en niet gezien worden’ worden gebruikt als startpunt om biomimicry te ontdekken.

Voor het beeldscherm ligt een bak met twee knoppen. In de bak zit een verlagings waarin de losse dieren activatieblokken (nr 1 – 5) in geplaatst kunnen worden.

Materiaal:

- A. Beeldscherm voor digitaal prototype
- B. Laptop dat digitaal prototype runt
- C. Extern bluetooth toetsenbord
- D. Arduino
- E. Arduino arcade buttons
- F. NFC reader
- G. Vier/VijfNFC tags
- H. Vier/Vijf dier – activatie blokken

Methode:

Observeren:

- Begrijpen bezoekers hoe de installatie werkt (interactie)? Weten ze wat ze moeten doen en wat ze moeten plaatsen?.
- Leidt de installatie tot een gesprek bij bezoekers?
- Ontdekken ze meerdere gebeurtenissen/dieren

(mogelijke) Interview vragen achteraf:

- Wat hebben jullie geleerd vandaag?
- Kunnen jullie uitleggen wat biomimicry is?
- Kan jij je herkennen in de gebeurtenis?

Evaluatie vragen formulier:

- Ik begrijp wat ik moet doen?
- Ik vond dit leuk om te doen?
- Leg kort uit wat je hebt geleerd.
- Ik kon mij herkennen in de gebeurtenissen die waren benoemd?
- Zal je nu vaker (in de toekomst) naar de natuur kijken voor het zoeken van oplossingen?

Documentatie:

- Foto’s
- Notities maken
- Anoniem citeren
- Observatie
- Evaluatieformulier

Data-analyse:

Foto’s en quotes wil ik gaan gebruiken om mijn documentatie te versterken en onderbouwen. Observaties zullen gebruikt worden om te ontdekken welke aanpak bezoekers prefereren en of ze de installatie begrijpen. Het evaluatieformulier zal inzicht geven in de voortgang ‘deeper understanding’ en ‘Integration’.

The design tested in user test 3 Museon-Omniversum

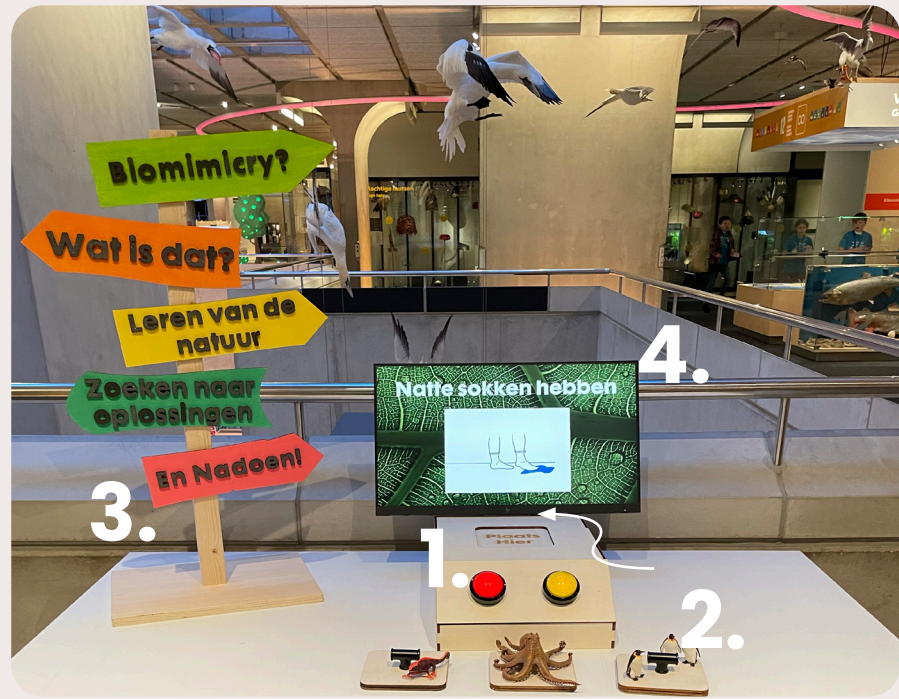
1. The first step is where the visitor is asked to choose an event by clicking on the buttons.



2. After watching a video clip wherein the visitor has to choose a question to solve, the visitor is asked to place an animal-block in the designated area (Plaats Hier). The correct video will activate if the right animal-block is placed.



3. This is an information sign to convey the subject of the exhibit to the visitor. It depicts a simplified version of what biomimicry entails.



4. Depicts the step-by-step screens of one event with explanations next to it. The event 'Sliding on the stairs' is addressed.

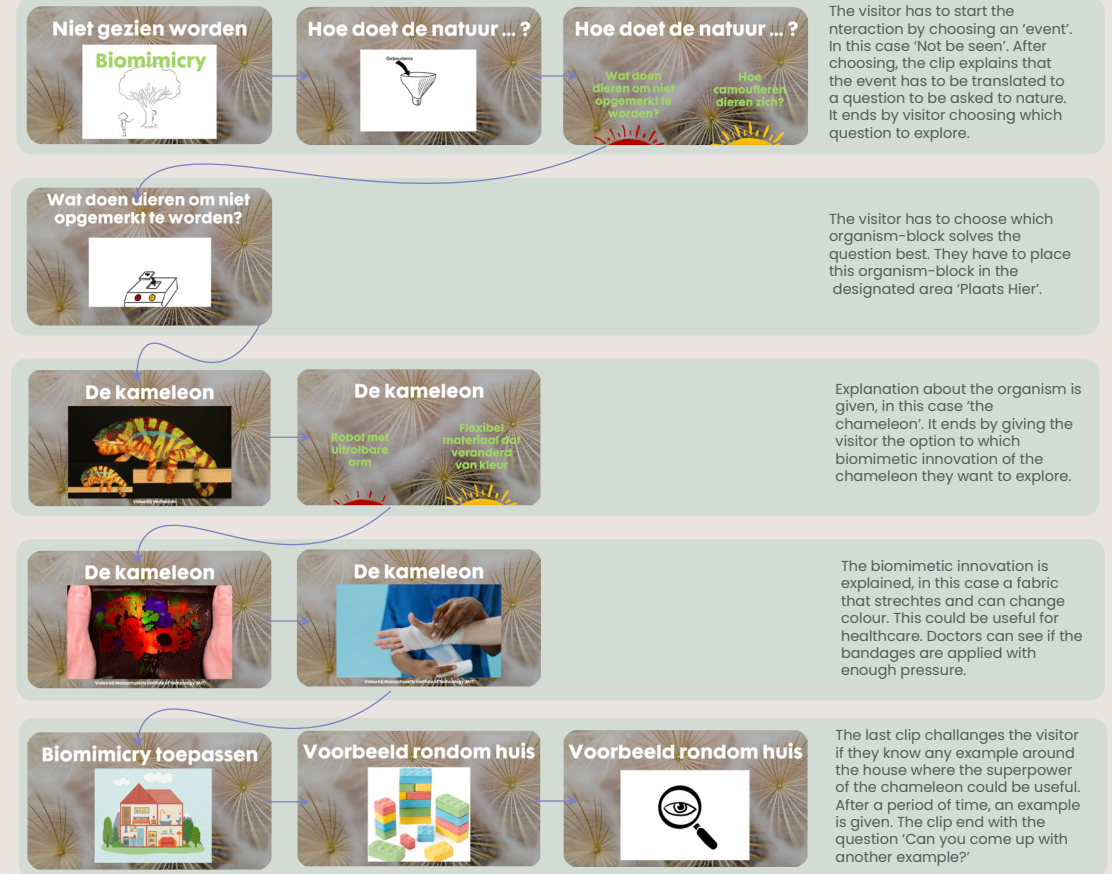


Figure K1: Complete setting of User test 3 in Museon-Omniversum with allocating numbers for explanations. The first two steps represent the steps the visitors need to take to complete the interaction of the prototype exhibit.

Explanation of the exhibit approach

The visitor could choose the one they liked by pressing the red button. The following clip explained that the event has to be translated into a question to ask to nature. After choosing the question to their liking, they have to place the right organism in the designated area. The organism-block will either play the next clip about the organism or tells them that another organism has a better fitting characteristic. In the end, they again have the option to try out applying biomimicry themselves or discover another event.

The concept is visualised in Figure K1 and the decitions tree is depicted in Figure K2..

Evaluating the concept ‘Superpowers in Nature’
Summary of user test

The data from this test will be used to see if the design goal of this project is achieved. Based on this final user test, recommendations will be proposed to Museon-Omniversum. A summary of user test 3 can be seen in Table K1. The user test was held in the same place as the previous one. First floor, near SDG 13 – Climate Action, SDG 14 – Life below Water and SDG 15 – Life on Land.

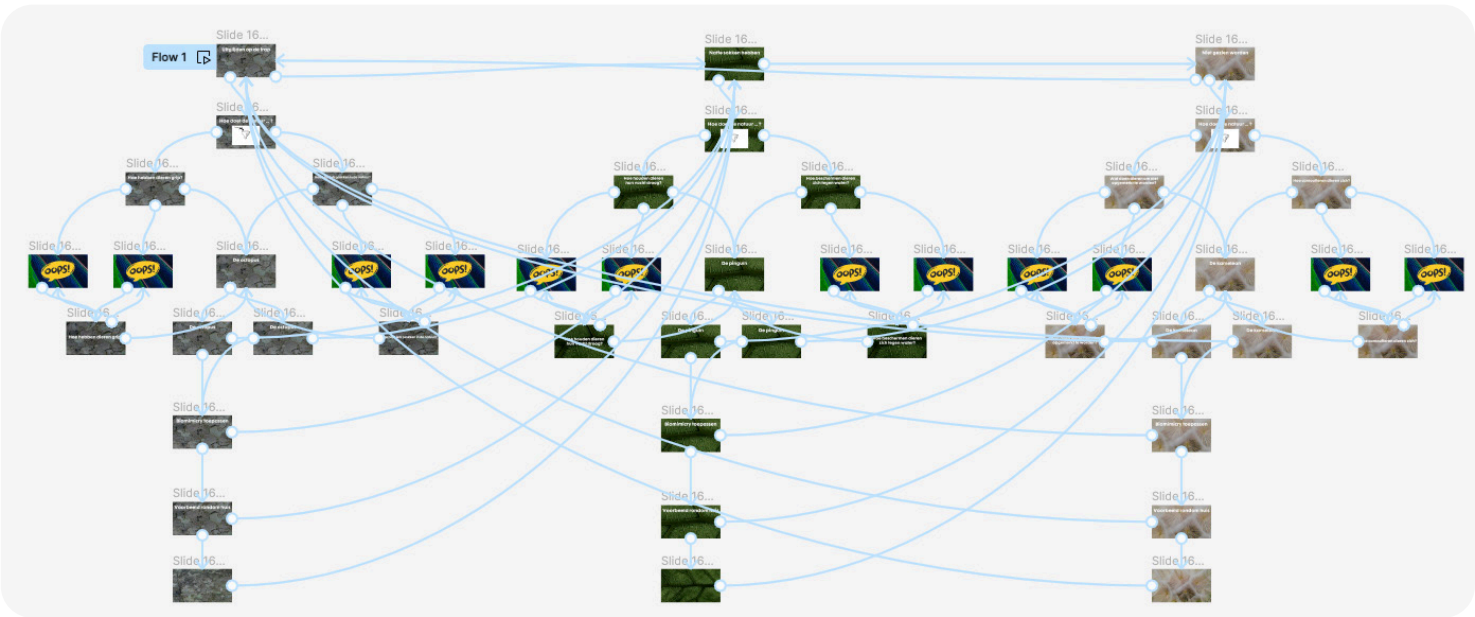


Figure K2: The three decisions trees for each ‘event’. The third one, not be seen, is explained in Figure K1.

Table K1: Summary of user test 3 in Museon-Omniversum.

Set-up user test 3 in Museon-Omniversum

Who 17 families observed	Role of Researcher The researcher was present at all times, but took distance from the set-up. Families could approach in their own time and discover the exhibit. They would be approached after finishing the ‘flow’ and were asked to fill out an evaluation form.	Intention 3. What kind of social interaction does the exhibit evoke? 3A. To what extent do visitors reflect on biomimicry through their own participation and discussions among families? 3B. To what extent do they expect to refer to biomimicry in future scenarios?
What Validate the design with respect to the design goal through the research questions. Discover existing knowledge of biomimicry in the visitor.	Research question Knowledge exploration 1. What do visitors recall about biomimicry after interacting with the prototype? 2. Are visitors stimulated to discover multiple animals/solutions?	Usability 4. How do visitors perceive the interactive experience of the prototype? 4A. Do the visitors understand the flow of the prototype?
When The last weekend of January (27th and 28th) during The Hague Tech month.	Where First floor, between SDG 13 – Climate action, 14 – Life below water & 15 – Life on land in the One Planet exhibit. ‘	
Why To evaluate how the concept exhibit fulfils the design goal.	How Data is gathered through observations and an evaluation form, which are used to answer the research questions.	

Reflection

Unfortunately, the test weekend was not as busy as expected. During the test day, most families did not fit the target group as most children were below 8 years. Subsequently, the prototype started malfunctioning. The videos would not load. The expected cause is that it runs on an open WIFI source of Museon-Omniversum, and as more people use the network, the videos take longer to download. No participant completed the flow, and therefore, no evaluation form could be handed out afterwards. However, some research questions as stated above, could be answered by observations only. They are addressed in the findings. Furthermore, this test was built on the evaluation of user test 2. Participants mentioned that they liked having the ‘voting’ option within the prototype. However, during the ideation and development of the prototype of user test 3, one key aspect: that visitors would press buttons too soon, was forgotten and not taken along in the design loop. User test 2 showed that some participants pressed the buttons too eagerly, playing videos over each other. Due to malfunction, they were disabled, and the researcher was in control. Thus, the assumption stuck that ‘buttons’ would work in a museum context. However, this setting proved again that buttons are a distraction if not used correctly.

Findings

As said, not all research questions could be answered by observations only. An additional or adjusted test has to be performed to find answers to the other research questions. Below, research questions 2, 4 & 4.1 are addressed.

Are visitors stimulated to discover multiple animals/solutions?
Observations showed that visitors were eager to place the three animals in the designated place to discover the animal’s aspects. Eleven out of seventeen visitors were playing with the animal-blocks and waiting for something to happen after placement. When the first animal-block did not start anything, they would place a second and so on.
How do visitors perceive the interactive experience of the prototype?
Although the prototype was approached with interest, most visitors got easily bored as they

- 1) Did not know what to do.
- 2) Missed the background information presented in earlier videos (by pressing too soon on the buttons)
- 3) Malfunction of the prototype

In all cases, visitors left the prototype before the end of the flow. Interference by the researcher often did not help as the decision tree could not return to the previous video. They would have to start over again and most visitors did not want to. In two cases, visitors were willing to, but this was followed by malfunction of the prototype: not loading of videoclips.
Do the visitors understand the flow of the prototype?
The prototype was often approached by visitors with an interesting attitude. However, no one listened to the audio of the clip, wherein it was explained what to do. Some would start placing the animal-blocks while others impatiently started pressing the buttons. Placing the animal-blocks had no function in this stage of the decision tree and showed no feedback to the visitor. The latter, pressing the buttons, led to activating the next clip. Then again, they would press too soon, missing the information told in the clip. The only time visitors would start to listen to the video was when the buttons were disabled, as one of the animal-blocks had to be placed. The visitor was sort of surprised by the question they had to solve with an animal’s aspect. They had no clue where the question came from. Alas pressing the buttons too soon.

Discussion

As discussed above, visitors were too eager to place the animal-blocks right away. However, that was not the correct way to address the prototype. The video explained that you first had to press one of the two buttons. By performing that interaction two times, the visitor would be asked to place the correct animal-block in the designated place. Only, no one listened to the videos to know what to do, as they pressed too soon.

This user test showed clearly that this setup of interaction does not work in the museum context for Museon-Omniversum. Buttons can, therefore, be regarded as too inviting for children, as they want to start right away. They would have to be temporarily turned off to force the visitor to listen to the video.

It can be argued that the videoclips can be made shorter. However, the information given is at its minimal. Reducing the information down would jeopardize understanding the concept of biomimicry. This can be tested in future user tests if it proves to be possible. Another factor that may play a role is that the videoclips are not the ‘prettiest’ yet. They were quickly derived for this user test only and not at its finest level to present in a museum context. This could have been a factor for low interest by the visitor.

Arduino code

```
1  #include <Keyboard.h>
2
3  const int button1Pin = 2; // Pin for the first button
4  const int button2Pin = 3; // Pin for the second button
5  const int led1Pin = 4;    // Pin for the LED corresponding to button 1
6  const int led2Pin = 5;    // Pin for the LED corresponding to button 2
7
8  void setup() {
9    Serial.begin(9600);
10   Keyboard.begin();
11
12   pinMode(button1Pin, INPUT_PULLUP);
13   pinMode(button2Pin, INPUT_PULLUP);
14
15   pinMode(led1Pin, OUTPUT);
16   pinMode(led2Pin, OUTPUT);
17
18   // Turn off LEDs initially
19
20   digitalWrite(led1Pin, HIGH);
21   digitalWrite(led2Pin, HIGH);
22 }
23
24 void loop() {
25   // Check the state of button 1
26   if (digitalRead(button1Pin) == LOW) {
27     Serial.println("Button 1 pressed");
28     Keyboard.write('A'); // Emulate key press 'A'
29     digitalWrite(led1Pin, LOW); // Turn off LED for button 1
30     delay(1000); // Debounce delay
31   } else {
32     // Button 1 is off, turn on LED
33     digitalWrite(led1Pin, HIGH);
34   }
35
36   // Check the state of button 2
37   if (digitalRead(button2Pin) == LOW) {
38     Serial.println("Button 2 pressed");
39     Keyboard.write('B'); // Emulate key press 'B'
40     digitalWrite(led2Pin, LOW); // Turn off LED for button 2
41     delay(1000); // Debounce delay
42   } else {
43     // Button 2 is off, turn on LED
44     digitalWrite(led2Pin, HIGH);
45   }
46 }
```


Appendix L - Findings User Test 3 Primary School

This appendix explains the findings of user test (3) held at the primary school. Figure L1 depicts the evaluation form that was handed out.

Observaties

- Nobody discussed among peers to come up with an example of their own before seeing examples included in the prototype. They immediately pressed the buttons to see the example given.
- All children are directly drawn to the screen, rather than exploring the surrounding material.
- Most pupils discussed among themselves which animal they wanted to explore (6/8)
- A few pupils did not memorize the word 'biomimicry' and asked what it meant when filling in the evaluation form (4/16)
- Some duos were conflicted as to what button to press when the video said 'Press any of the buttons'. They would often alter the one pressed, e.g., starting with pressing the red button, in the next choosing option, they would press the yellow button and vice versa. Two teams did discuss which buttons to press before they continued.
- All pupils pressed the buttons at the end of the 'flow' wherein they were asked if they wanted to discover another characteristic of an animal. However, when the researcher explained that for this test, only the octopus worked and they could discover the other superpower of the octopus, two teams said no (4/6 said yes)

Interview vragen

- All children prefer a physical object to 'scan' rather than digital buttons. They do like the interaction of placing an animal-block and having the ability to vote.
- 'otherwise everything will be or will remains digital (translated from Dutch)'
- 'voting keeps me engaged with the content of the product (translated from Dutch)'
- Children like the appearance of the 'animal-blocks'. It makes it look cool
- Children were curious why different products were laying around the test set-up (socks with nops, suction cup and army outfit)
- When asked what they have learned/ can remember, they all referred back to the superpowers of the octopus. Only one team could also recall how the octopus was inspiration for the flexible material that could change from 2D to 3D.
- Learning about the ability 'camouflage' was new to many (6/8 teams).

Ontdek Biomimicry

Wat vond jij ervan? Zet een stip op de lijn.

Ik begreep wat ik moest doen

Ik snapte het niet zo goed Ik begreep wat ik moest doen

Ik vond dit leuk om te doen

Niet zo leuk Heel leuk

Ik kon mij herkennen in de gebeurtenis of voorbeelden

Nee, niet zo Ja

Ik ben gaan nadenken over oplossingen in de natuur

Nee, niet echt Ja, zeker

Ik ben nieuwsgierig naar andere oplossingen in de natuur

Nee, niet echt Ja, ik ben nieuwsgierig

Wat is het eerste waar jij aan denkt bij 'Biomimicry'? Schets of Leg uit in woorden

Figure L1: Evaluationform handed out at the end of the user test.

Analyse evaluatie formulier

Scale-based

I understood what I had to do.
 $4+5+4+4.5+4+4+5+4+4+4+5+5+4+3+5+4.5=69/16=4.3$

I liked to perform the interaction.
 $4.5+4+4+5+4+4+5+4+5+5+4+5+4.5+5+5+4.5=72,5/16=4.5$

I could recognise myself in the examples given
 $4+3+3+4+5+3+3+4+4+4+3+3+3+3.5+5+4=58,5/16=3.7$

I started thinking about solutions in nature.
 $3,5+3+4+4+3+5+3+3+4+2+4+3+3+3.5+5+5=58/16=3.6$

I am curious about other solution taken from nature.
 $3+4+5+5+4+5+4+4+5+5+5+5+4+5+5+4.5=72,5/16=4.5$

Open question responses evaluation form

- What is the first thing that pops up into your mind by 'biomimicry'?
- Nature, octopuses, camouflage
 - Nature, biology, chemistry, the ocean, small
 - Nature, solutions, camouflage
 - Small, watching bacteria through a microscope
 - Problems in nature
 - Solutions to problems
 - Something smart that nature has invented (through evolving)
 - I want to have more arm as a human
 - Small things in nature, handy stuff, how you can mimic nature.
 - The capabilities of nature, like 'superpowers' of animals
 - We can learn from animals, just like shown in the video clip
 - Parts of organisms we can mimic
 - Microscope, small, cool, weird
 - Animals, nature