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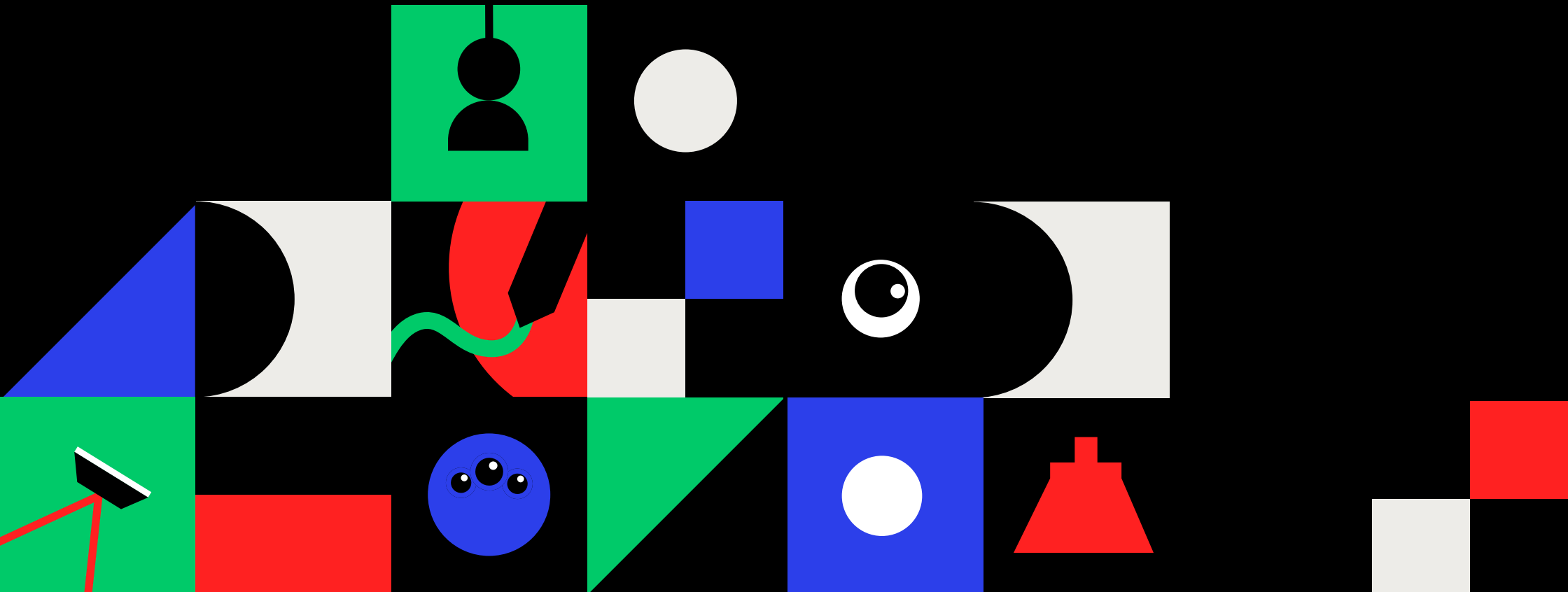
Turning Pages

Rethinking digital learning in the classroom context



Candidate

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Project title

Turning pages - Rethinking digital learning in the classroom context

Main discipline

Interaction design

Supervisor

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Master in Design
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Abstract

In recent years schools have undergone an extensive digital transition. This change has opened the doors to question how we utilize the tools at our disposal, and how we challenge the way we interact and learn.

Turning Pages is an explorative design project searching for ways to bring thoughtful, relevant, and social learning experiences to the classroom setting. It takes on primary education, where digital devices have become the main tool for a majority of learning activities.

Through this project, I started looking at the effects of digitalization, and the new potential it has brought to the market. The findings resulted in three main areas of exploration: 1. How can digital devices support the social dynamic in the classroom? 2. How can digital devices support the teacher in their freedom of method? and 3. How can difficult concepts be taught in a more engaging way?

These areas became the basis of a series of explorations, through which I developed my final concept “Kadabra”. The solution is a platform, and system, creating the foundation for a wide range of dynamic classroom learning activities.

Contents

01.

INTRODUCTION

Involvement

Motivation

Growing up, I got first-hand experience of the rapid transition caused by the digitalization process.

A strained back from a bag stacked with books, along with a desk littered with eraser dust, turned into a lightweight laptop and the “command + Z” tool over the course of a few years.

It is hard to deny that digitalization has lessened some of the burdens that may now have been buried in memory. However, I continuously wondered whether the next generation would come out to be better equipped than the one before, having brand new resources at their disposal.

This project was a way for me to question some of my past experiences in relation to a bigger context, both when it comes to learning and the use of digital devices.

My Role

The digital education market is massive, and transformation within existing services has proven to be slow both in implementation and research.

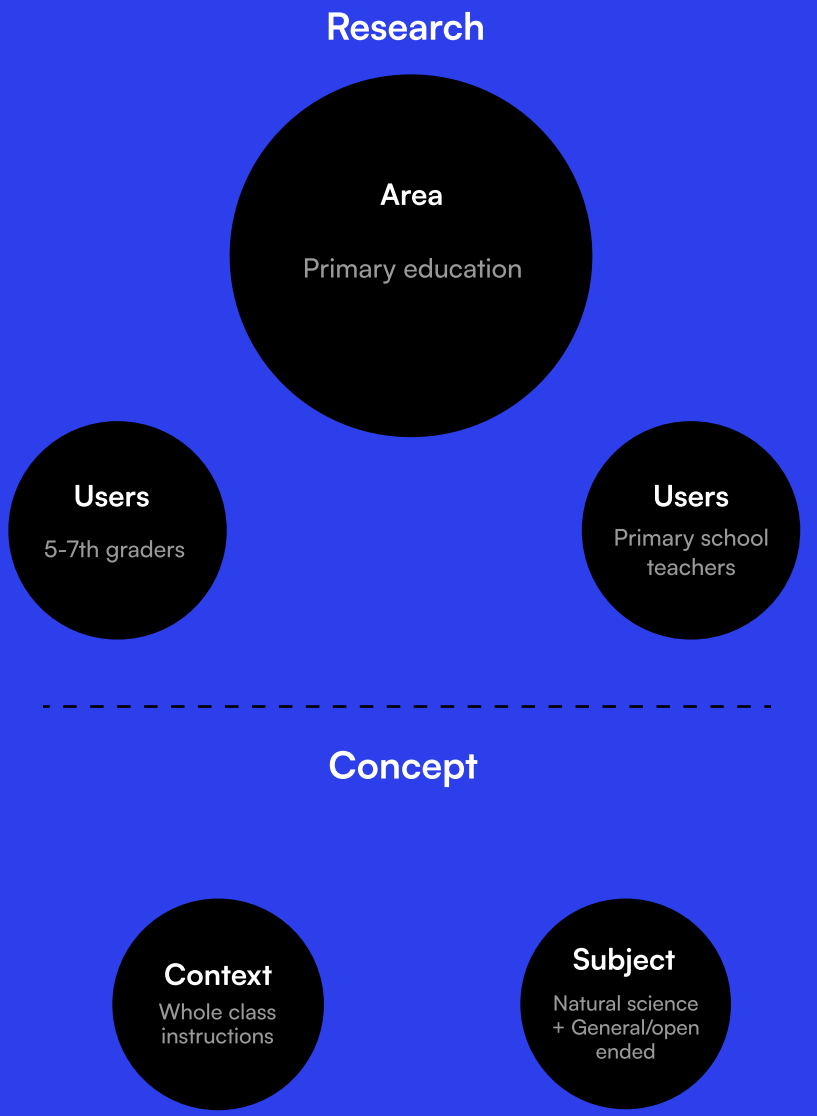
My role is to attempt to scour a new outlook regarding some of the missing aspects of digital devices, through the use of design as an exploration tool.

I also view this project as a way to contribute to a larger discussion that recognizes some of the opportunity space that exists within digital education.

Scale

This project takes on primary education in Norwegian schools, with a larger focus on 5th -7th-grade pupils, including teachers of that corresponding age group.

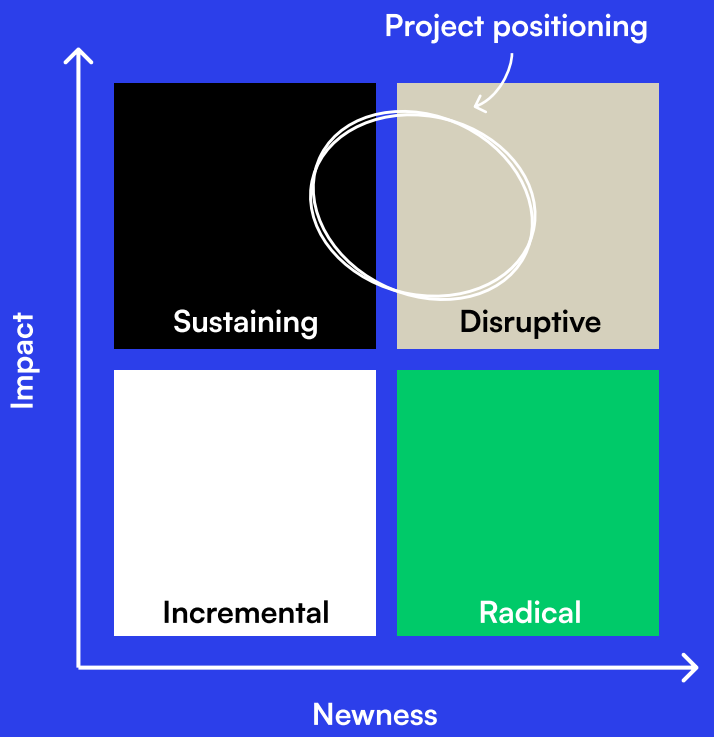
During the exploration phase, the scope was further limited to a solution that can be positioned in the material and teaching aid market, with whole class instructions as the primary context.



Project positioning

Budget distribution in schools is limited, and the implementation of new technology is costly. For that reason, I decided to build on top of existing infrastructure in schools and look into how learning can be achieved in ways that have the prospect of contributing more direct value to the market.

While the topic of innovation is a complex subject, I based the evaluation of my project positioning, on a model by Clayton Christensen. Disruptive innovation refers to a concept that creates a new value network within an existing market, or by creating a new one (Bower, Christensen, 2022). The project can be seen as primarily positioned within this category, as it expands upon an existing market and certain existing ideas, while also providing new ones. The primary goal was to use design lead innovation to challenge a quality gap in digital learning.

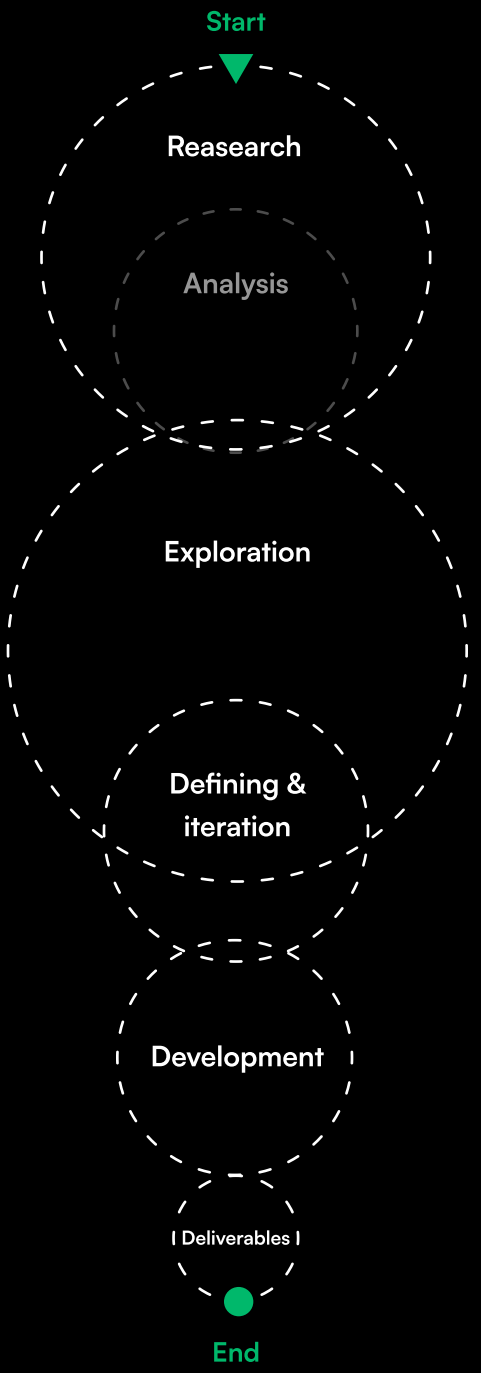


Approach

The project was initiated with a broad objective that attempted to comprehend some of the complexities within digitalization, along with the opportunities and limitations.

The aim was not to tackle a specific problem, but rather to discover new possibilities through both an opportunistic and issue-oriented outlook.

Throughout this report, I will provide more context on specific parts of my process and design methods.



Expert & stakeholder interviews
User interviews
Desk reasearch

System mapping
Market mapping
Case studies
Problem analysis
Opportunity areas

Sketching
Idea clustering
Conceptualisations
Inspiration board
Feedback sessions

Testing
Evaluation
Scoping
System mapping

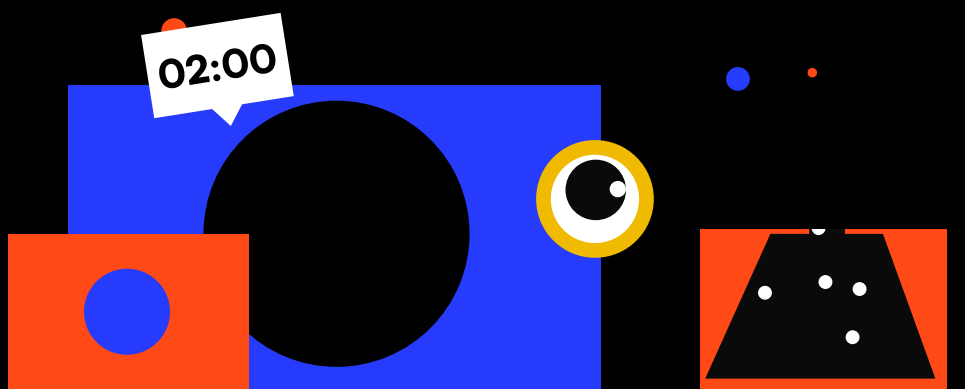
Prototyping
Branding explorations
Testing and feedback
Iterations

Evidencing
Prototyping

Outcome

The final concept is the initial proposal for a platform, named Kadabra. The solution provides the means to house a range of interactive and social classroom learning experiences.

KADABRA



02.

BACKGROUND

Where is the laughter? Where is the aliveness? Where is the kinetic and tactile group experience?(...) Where is the kaleidoscope of everything humans have been doing naturally in the classroom before e-learning came along?

Chris Alexander Head of the Technology Enhanced Learning Centre at the University of Nicosia

Going digital

Distribution

Norwegian schools are among the world's top regarding hardware and digital software availability in the school system(G.Torgersen, 2018).

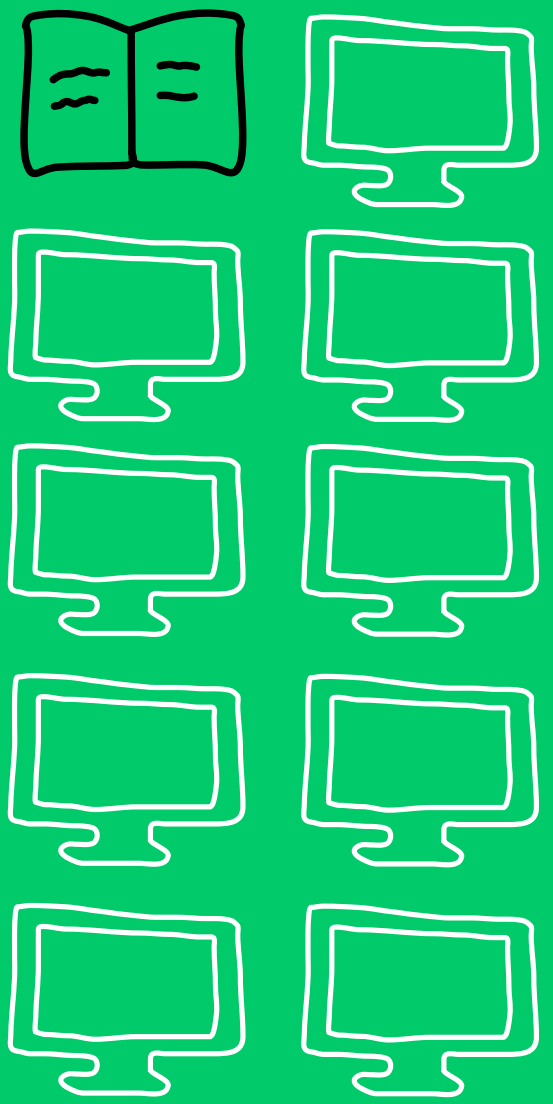
Digital devices are no longer just a way of keeping material up to date or storing student test scores. For many it has turned working life upside down, having to adapt to new digital ways of working.

Both the steam and rush of digital implementation appear to go faster than the ability to make good tools.

> **Some see it as if we are facing a fourth industrial revolution with the steam, the electricity, and electronics turning production methods and working life, upside down. What is different now with the fourth digitization, is that development is said to go exponentially**
>
> *Ministry of Education, Future, Renewal and Digitization.*

Nine out of ten students In 5th - 7th grade have their own digital device. A majority of which are touch supported devices such as tablets and Chromebook,

2021 numbers by the Norwegian ministry for education (Udir, 2021)



Transformative Events

The Digitalization strategy

For several years, norwegian classrooms have undergone a digitization process. In 2017 the Norwegian Ministry of Education launched its most recent one “Future, Renewal and digitalisation” (Ministry of education, 2017).

This strategy highlights among other things, a larger focus on digital tools, literacy and competence. With the main goal of honing the new potential digital tools provide to the education sector.

The Pandemic

The recent pandemic had many transition to a new and unusual setting. As a result, the Ed-tech proved its importance within the education sector

“With the corona pandemic, concepts such as **digital home schooling** and **digital teaching** have quickly become everyday terms.”

(Heie,2021)

The situation also demonstrated the value of the classroom as a social learning space. Difficulty of communication, and the lack of social connection were some of the main aspects teachers and students expressed missing.

“What I missed most was the difficulty of participation in every way. It was hard to get students to contribute.”

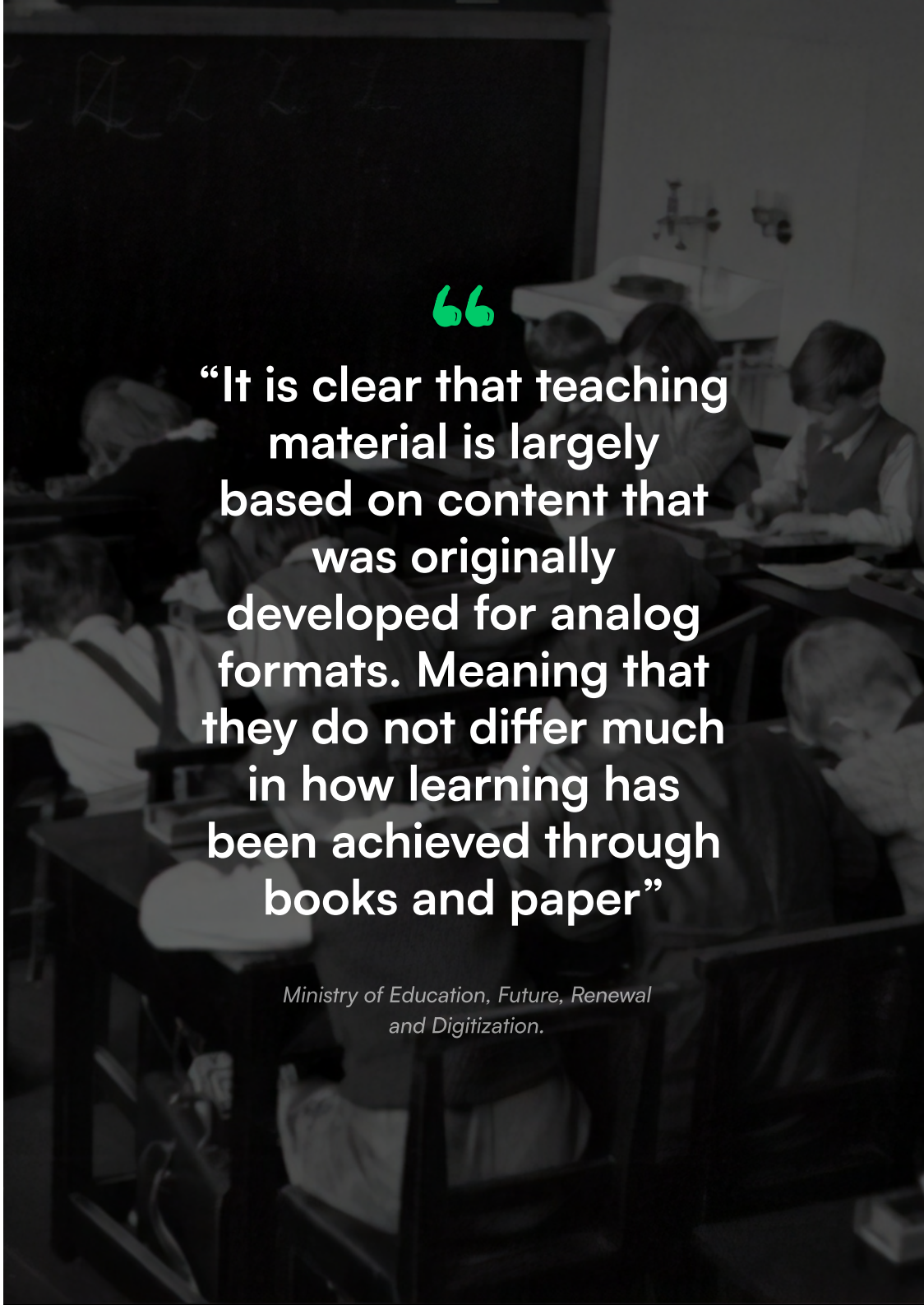
Teacher, male

Paper to pixel

Emulating old ways

Through years of digitalization, new services have emerged in the market, more devices have appeared in the classroom and new products have landed in the hands of the learners. Digital devices have become regular part of their day-to-day lives.

However, in the face of new technological advancements, numerous examples of book adaptation have proven to emulate old ways of working.



> “It is clear that teaching material is largely based on content that was originally developed for analog formats. Meaning that they do not differ much in how learning has been achieved through books and paper”

Ministry of Education, Future, Renewal and Digitization.

New roles

In defence adaptation, there is an important function for curriculum interpretations such as books. For many teachers, they work as a structuring element in both lesson planning and conveying educational content (Gilje, 2016).

This leads to a new question, as in this transitionary period for education, screens have landed somewhere on a middle ground, as books turned to pixels. There doesn't yet seem to be a clear answer to where they play a part in the context of learning.

In our rush for the future, we let technology run over the human and the humane. We increased our productivity by supercharging the old tools, the old representations and the old paradigms, instead of inventing new ones that are native to the new medium.

(Halme, 2021)

03.

RESEARCH

The digital market

METHOD HIGLIGHT

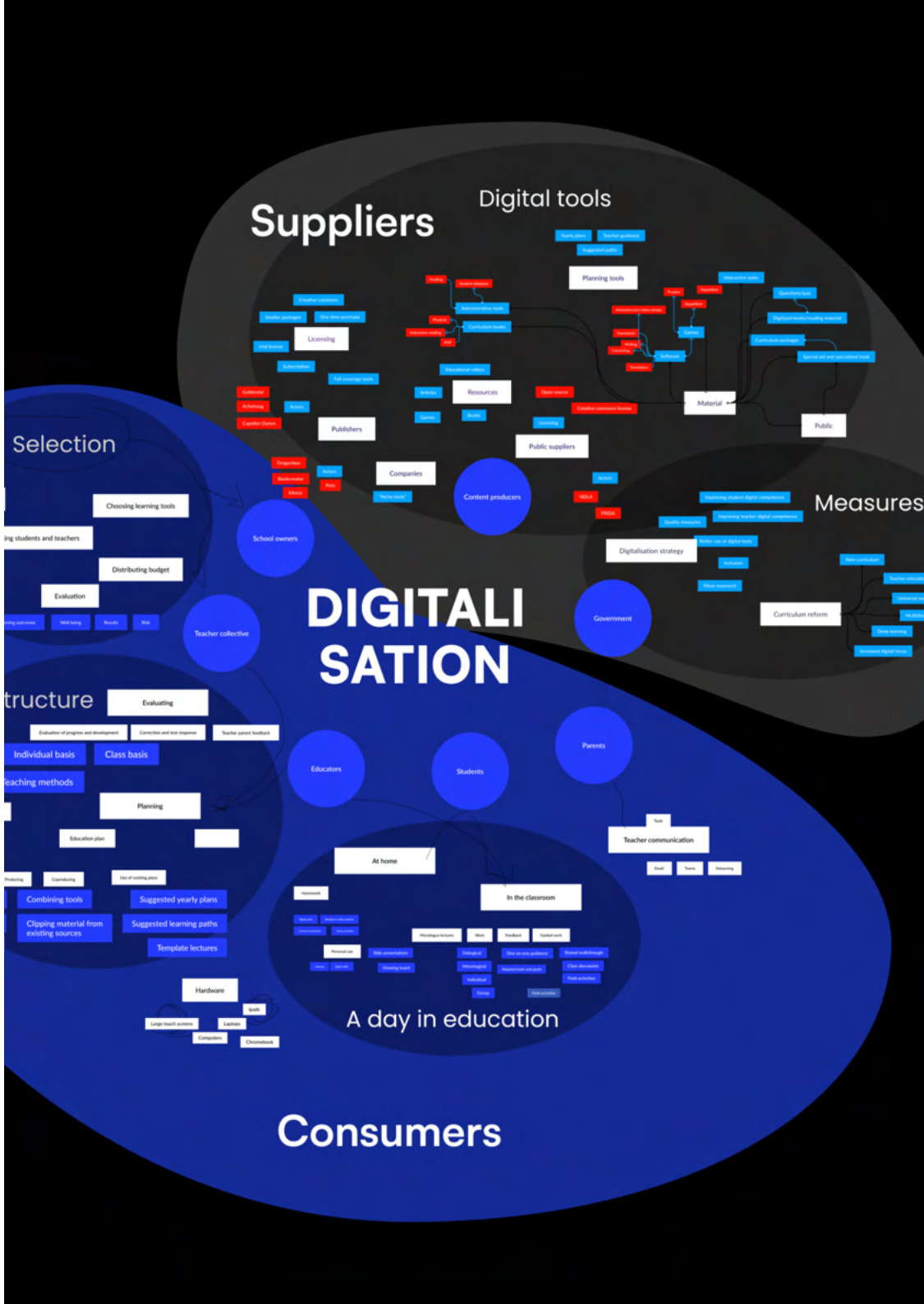
Systemic map

This project began by looking through a wide lens. In order to get an understanding of today's, consumers, suppliers, and systems, I used a comprehensive map as a structuring element for the research.

The map was derived from insights during desk research and was supplemented with content from interviews and talks with experts, including stakeholders from among others Gyldendal and Aschehoug.

Highlights

- There is a vast sea of educational products
- Schools have different pedagogical ambitions when it comes to digital content
- Adaptation is a reocurring theme
- Restricting licensing can affect free use

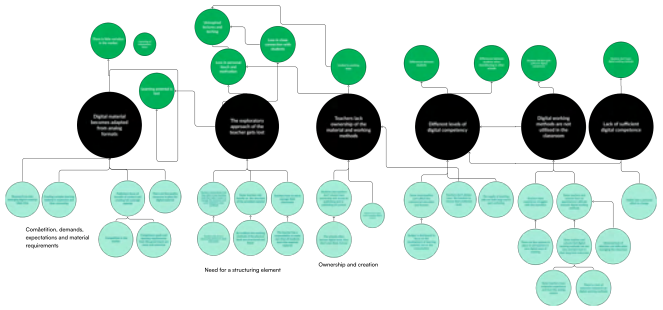


Adaptation

The digital education market consists of an extensive amount of materials, resources, and teaching aids. Among the largest holders are publishers, who previously held the market through books (UUtilsynet, 2017).

There are several reasons why digital material, has been adapted from analog content. Consumer demands, expectations, cost, and competition are namely some of them.

There is a broad curriculum to cover. Large changes like the recent curriculum renewal demands for a new array of content to be supplied to schools. Reproduction, therefore, is an important prospect when it comes to range.



METHOD HIGLIGHT

Problem tree mapping

I took advantage of the problem tree mapping method to analyze the anatomy of cause and effect around some of the issues surrounding the digitalization process. It works by separating core issues(the stem), causes(the roots), and lastly the effects(Branches). This assisted in understanding some of the main causes for why content adaptation was caused on a systemic level.

Findings related to adaptation

- Ease of production
- Market competition
- Curriculum updates
- User expectations
- Tradition and trust in the medium
- The need for a structuring element
- Habit of use and tradition

State of the art

When diving into the vast market of educational products, there are a couple of innovative solutions standing out from the crowd.

Poio and Dragonbox both offer a unique approach to teaching core concepts in their respective themes. Poio, provides a way to practice words and letters visually, audibly, and through touch. Marking out letters, and the composition of syllables.

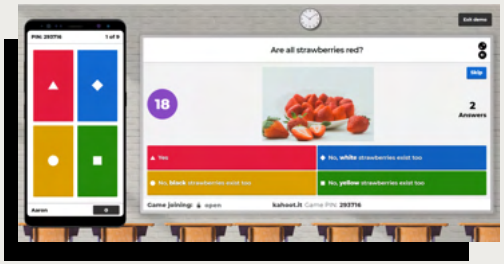
Dragonbox offers a similar approach, but with creatures that act as abstract representations of numbers. They also both work with variations of repetition training models.

Kahoot was an inspiration in this project, especially in the way it takes advantage of the existing screens in our pockets. Although limited to multiple choice questions, its simplicity has garnered recognition in the private and educational market(Albert,2022).

Dragonbox

Poio

Kahoot

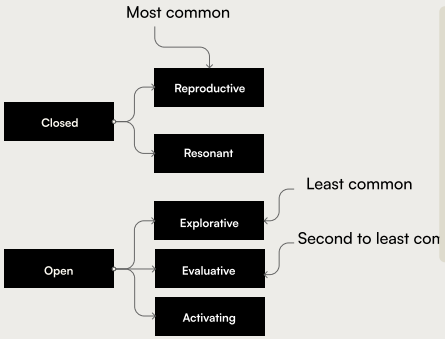


METHOD HIGLIGHT

Case analysis

I got the opportunity to access some educational producs through both Gyldendal and Kikora. Through those, I uncovered important underlying structures, ideas and patterns present in many of them.

This method helped in gaining an important overview of how progression, material and tasks are structured, as well as some of the carefully thought through systems, that could be leveraged.

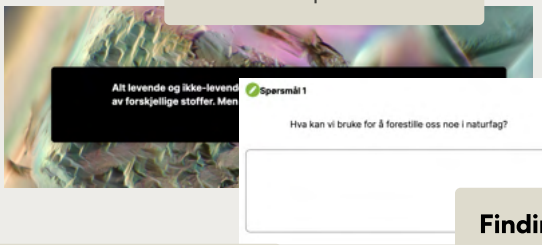


Finding 1

Reproductive tasks, i.e retelling facts or definitions were common, explorative, or investigative tasks were few.

Finding 2

An abundance of bite sized text, drag and drop and static input fields.



Finding 3

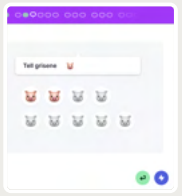
Approaches to questions

- Introductory/inquisitive
- Supportive of concept/ understanding
- Reflective/recollection

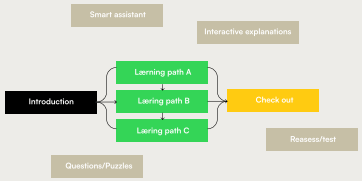
Finding 4

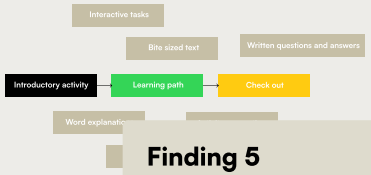
The importance of switching activities. Alternating between consumption and doing.

Kikora



Skolestudio Refleks





Finding 5

Natural learning paths - Going from introduction, base to reflection.

Space of Opportunity

Digital opportunities

When diving into the opportunity space the research was a lot about understanding possibilities within the existing devices at our disposal.

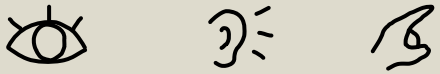
I drew inspiration from talks and writings by Bret Victor. He is known for his outlook on the future of technology and advocating the making of complex behavior both more useful and visible.

A highlight of his assertion is that digital devices have the means of simulating complex dynamic behavior, through simulations, explorable visuals, and dynamic content (Halme,2021).

Additionally, with emerging devices in the school system, such as tablets and Chromebook, we are now able to explore new possibilities such as AR tracking, accelerometers, cameras, and sound. The consensus is that existing infrastructure can contribute to a large quantity of new possibilities.

Discovery 1

Multi sensorial benefits



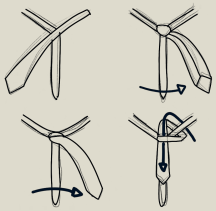
Discovery 2

Contextualisations, abstractions, symbolic abstractions

Out of context

At the beginning, the wide end of the tie should be on your right side and the other end should be on your left side.
Cross the wide end over the other end. Now three regions are formed (Left, Right and Center).
Bring the wide end underneath the narrow end from Left to Right. Then bring the wide end over from Right to Left.
Bring the wide end under the knot to the Center region.
Bring the wide end down and pass the loop in front. Ensure that the knot is tightened.

In context



Discovery 3

Simulations, Interactivity

Static image **Video** **Simulation**

Discovery 4

AR, accelorometers, touch, camera microphone

How do we learn?

When it comes to simulations, visuals, and interactivity they can only benefit so much unless provided with some level of academic relevancy(Gilje,2016) and achievable difficulty(Bjork, 2009).

Beyond the material consumed, learning can happen in a variety of ways. While there is a considerable amount of theories within learning psychology, a part of the research was to regard some of the common themes. I especially focused on cognitive psychology.

Varying conditions

One of the ways we can make learning more useful, is by varying the circumstances in which we do so, rather than keeping learning constant and predictable (Bjork, 2009).

One of the pitfalls of content adaptation, is that educational content can become linear and predictable, leading to numerous identical and expected patterns.

Motivation

Another gateway to learning is through motivation. And motivation usually occurs when a topic leverages a sense of curiosity through meaning, gives the ability of free choice, or gives a sense of mastery and challenge (Pink, 2009).

Cognitive psychology also differenciates between passive and active learning. Active learning is learner centric, meaning that the learner contributes. While inactive learning is teacher centric, and is usually about cosumption (Wieman,2014).

Both are important parts of in the learning process, however they each provide different benefits.

> “Very often it can be good for the students to get things systematized and visualized. But also be involved in it and somehow also contribute.”

Teacher, Male

Autonomy

Opportunity to make meaningful choices

Connection

Connecting collaboratively or to the real world

Mastery

Achevable difficulty

METHOD HIGLIGHT

Mapping external inspiration

Looking for more external sources for inspiration, I created a mood board including spacial and tangible elements, museum installations, games, and art.

Museums became an inspiration in this project, especially in how they demonstrate good use of context and space. Space can affect how we behave and relate to an experience. There, the space and screens become a part of the display.

What has been seen is that the interior affects how visitors relate to the environment. Colors, aesthetics and interactive elements directed at children changes their sound level and behaviour.

Petter Bøckman, Zoologist and university lecturer at the Natural History Museum

Context

The teacher role

Perhaps one of the most important areas to understand when looking into education is the teacher. I conducted several interviews both with current and former ones. Further, I mention my takeaways.

Planning

It is important to consider that teachers work very differently, and many develop specific routines and teaching styles. Some draw on a board and structure work in ten-minute increments, while others go through the material in depth.

Teaching can call for meticulous planning, dedication, and being able to move away from the script when necessary to leverage a teachable moment.

Lost in translation

While some teachers have taken the new digital transition head-on, for others, it has caused a feeling of constriction and a loss of connection with their students. Some experienced trouble in not knowing how to adapt to the new digital working ways.

Reliance on the structure of the material has made some feel a sense of passivity, where they become the secondary mediator to the material, instead of the primary instructor.

"The technology offers many possibilities, but is at the expense of the exploratory approach to the teacher. You want to be able to be close to the student."

Prior teacher, female

"Students are completely dependent on a skilled teacher explaining and "translating" between the app and the school's mathematical language"

(Sprukland, Blikstad, 2016)

The upsides

On the positive side, materials and tools can also provide the inspiration to leverage a topic.

“If you give a teacher motivational content that consists of text and images and sound, you are well on your way. Digital teaching aids can provide more variety and thus also more motivation”

Jannicke Ekenes Asp, Achehoug

“The right kind of material can help a lot. Where I can both perform something written and oral, or combine this with interactive and participatory things for the pupils. Exciting and visual meterial helps a lot in their understanding”

Teacher, Male

Autonomy

While the structuring material has an important role, teachers convey the importance of supplementing with their own content.

“I'm a fan of trying new things. The curriculum talks about how the students should explore for themselves. It creates that kind of natural curiosity. “

Teacher, Male

A feeling of ownership can play a role in being interested in what you teach. Museum teacher Petter bøckman described the importance of incorporating humor, sharing personal experiences, as well as incorporating questions that encourage the learners to think.

METHOD HIGLIGHT

Classroom observation

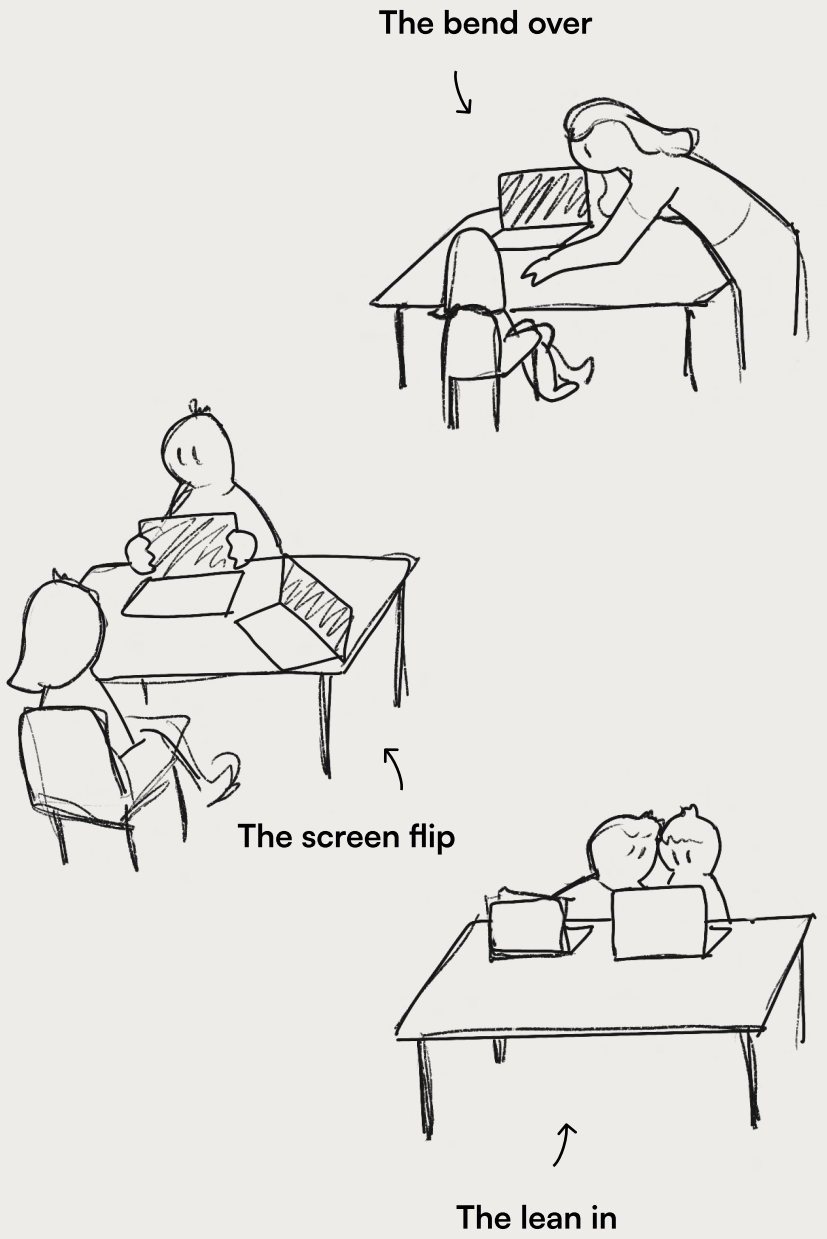
Learning happens not only through our own actions and processes but through the interaction with others in a shared learning community(Gilje, 2016). The classroom is a unique opportunity to learn as a group and connect minds.

I got a first-hand experience of the 5th-grade classroom, through an opportunity from Gyldendal.

It went to display some of the interesting social interactions that have become a norm with the incorporation of screen use.

Other findings

- Managing group attention can be a challenge
- There is a lot of planning and preparation involved in teaching
- Unexpected situations, disruption, and technical difficulties are a norm



The Learner

There were several reasons that converged to result in my scoping down to 5th to 7th grade. At this age, the curriculum material starts to become more complex, which was a good leverage point to explore certain digital opportunities. Narrowing down was also necessary due to the large developmental differences between age groups in primary school.

Some teachers, saw it a lucky place to be a teacher. At this age motivatoin and curiosity are prevalent, the competitiveness, but also social aspects play an important role.

Through my conversations with them, as well as teachers, I learned a lot regarding some of their characteristics and habits in the use of technology.

Findings

- Most are well versed at using digital tools
- Every pupil is different, there is no one tool fits all.
- Curiousity and motivation to learn is prevalent

Children in this age group have grown up with technology. They are well versed with tablets, laptops and controllers

Teacher, male

Natural science

Another part of the scope was the natural science subject. Science differs from other subjects through its teaching of complex and systemic concepts of nature. Concepts like solar systems, food chains, electromagnetic fields, speed, time, and microscopic particle behavior. Conceptual understanding is a crucial goal, and exploration, observation, and experiments are core elements to support that (Udir, 2020). Complexity is one of the main reasons why I found it relevant to explore this topic in combination with digital devices.

Opportunity areas

The findings from the research process resulted in these three opportunity areas.

1

How can digital devices support the social dynamic in the classroom?

2

How can digital devices support the teacher in their freedom of method?

3

How can difficult concepts be taught in a more engaging way?

03.

EXPLORATION

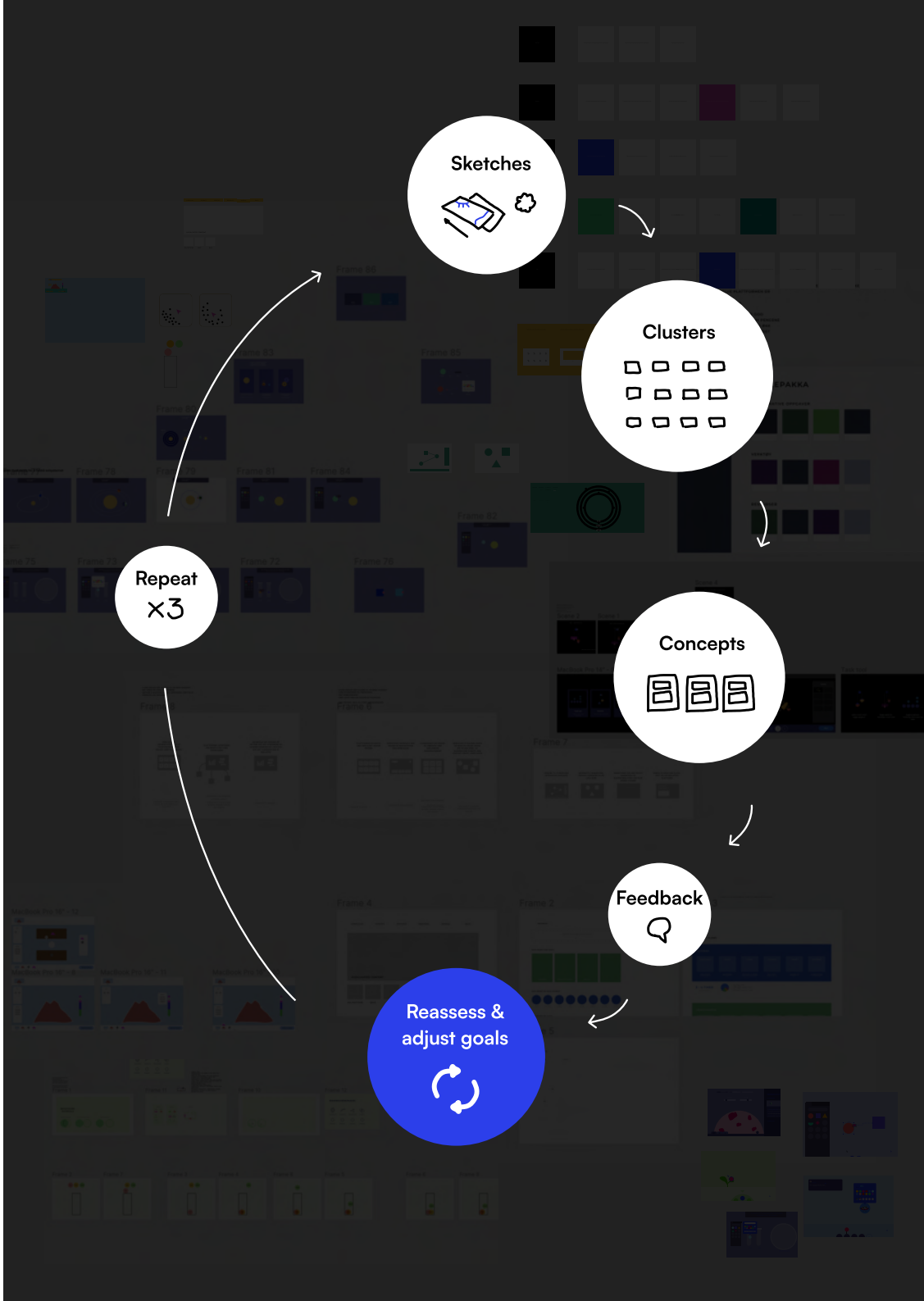
Initial ideation

Process

The initial exploration process can be thought of in three ideation loops.

In each round, I conducted sessions of low fidelity sketching that were later categorized into clusters.

Three ideas were turned into communicable probes, to which I invited experts, fellow students, and teachers to provide feedback. The feedback was used to further ideate, reassess and reiterate.



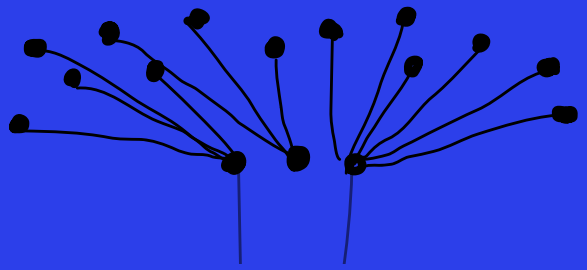
Learnings

Through two unsuccesful ideation loops and approaches, resulted in takeaways that I would later use in my final concept.

Learnings intial explorations

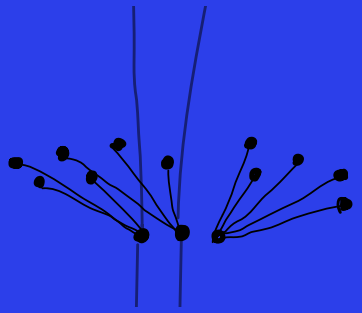
- Teachers & pupils don't nescessarily wish to create tasks from scratch
- Frameworks and design tools are important, but it's hard to make people use them on their own
- Planning tools are helpful, but when put into a larger context/goal
- Sandbox and simulation programs are engaging, but don't really challenge the existing market or use of digital devices on their own

During the rest of this chapter, I will be going through the third and final session in which I created the basis for my final proposal.



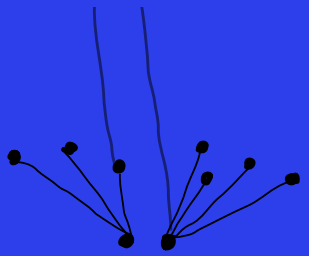
FIRST IDEATION

Innovation measures & Frameworks



SECOND IDEATION

Design systems, producer tools & sandbox formats



THIRD IDEATION

Screens

New Framing opportunity

Screens

The third and final exploration phase arrived at the last area of discovery: screens.

With that, the first screens I chose to work with were tablets. Touch devices are expanding their reach in the primary school setting, and they also have additional technological possibilities, such as accelerometers, touch screens, and AR.

WHY?

Classrooms have collected an abundance of screens, yet the devices have proven to limit the social learning experience.

Class monologues

Whole class instructions take up half of a school day on average (Gilje, 2016). Teacher monologues work as an important structuring element when it comes to consuming new topics, and understaning subsequent tasks and activities.

Going forward, the scope became to explore this context more.

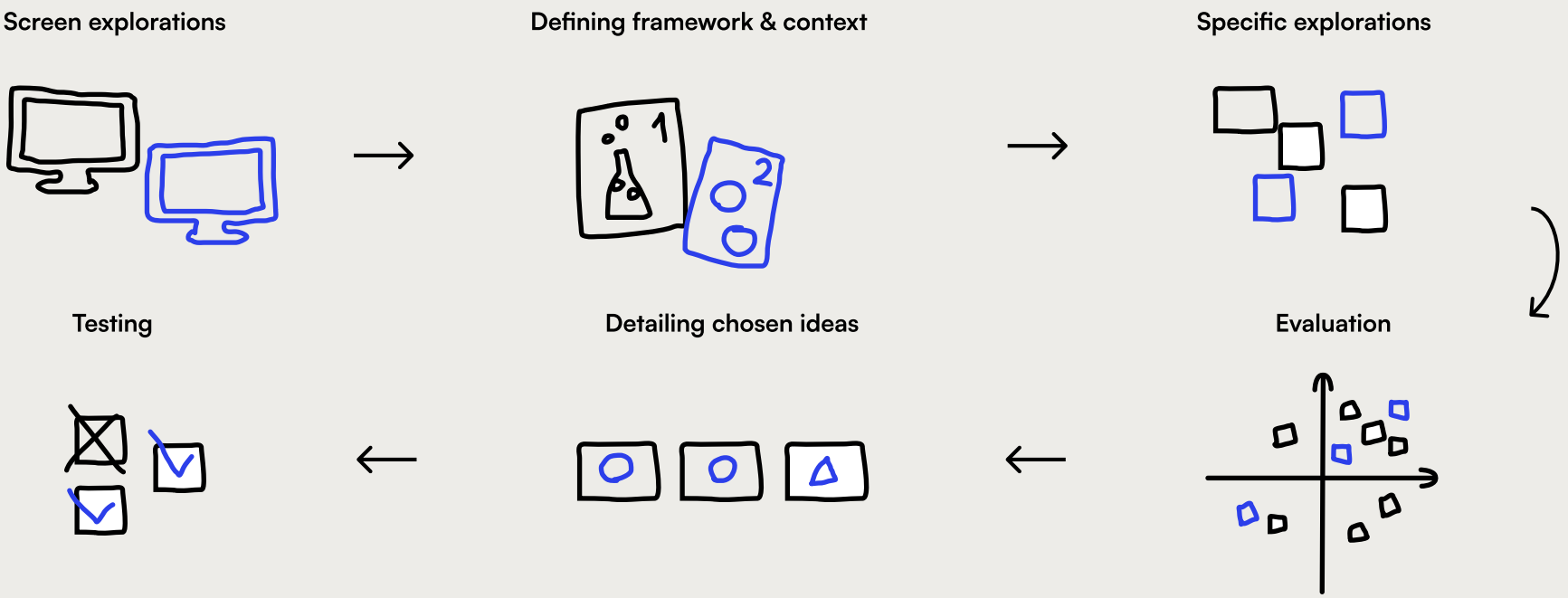
WHY?

The market is geared towards individual work. Solutions specialising in whole class settings are lacking.

Exploring screens

Overview

The new framing leads to the last sequence of exploration. In the following section, I outline how I arrived at the final concepts.

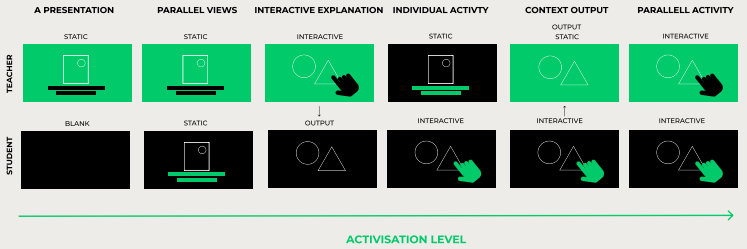


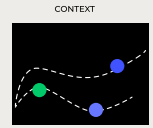
Explorations

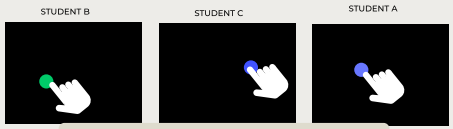
The new-found sketches uncovered that screens offer many new possibilities when working in contextual harmony.

Cooperative screens

What can you do with two screens that act in parallell? What are the possibilities if one of them is interactive, both, or none?





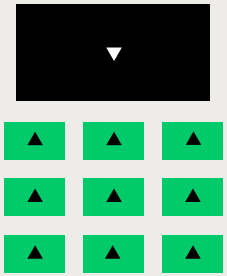


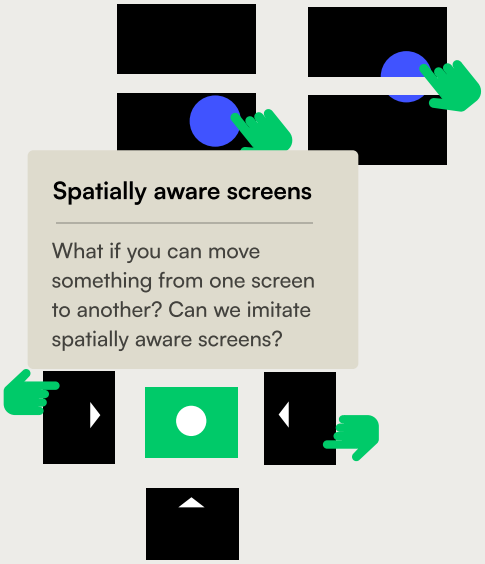
Levels of abstraction

Can we share two views of a representation through the use of multiple screens? This idea was based on ladders of abstraction (Victor, 2011).

The Jigsaw model

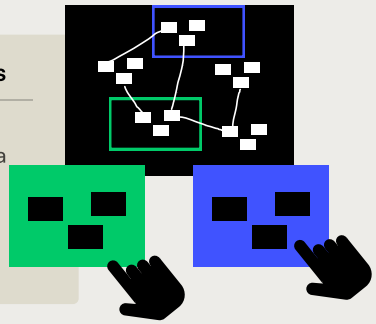
What if every screen had a different part of a puzzle? How would one work together to fill in the missing pieces of information? This idea was based on the Jigsaw learning model (Furberg, 2016).





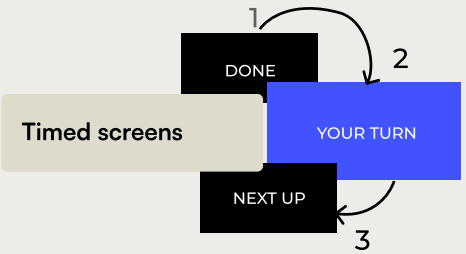
Spatially aware screens

What if you can move something from one screen to another? Can we imitate spatially aware screens?



Different zoom levels

What if every screen had an isolated part in a bigger picture? Can we learn more effectively by seeing both the zoom and the context?



Timed screens

The two part framework

Through the screen explorations, I discovered two prominent directions that could leverage the core values of my project.

Further, I highlight how these directions support whole-class instructions and learning progression in two different, yet interconnected ways.

Simulations

The first part, simulations, support learning by building conceptual understanding. Within the framework, they are based on concepts derived from the science curriculum.

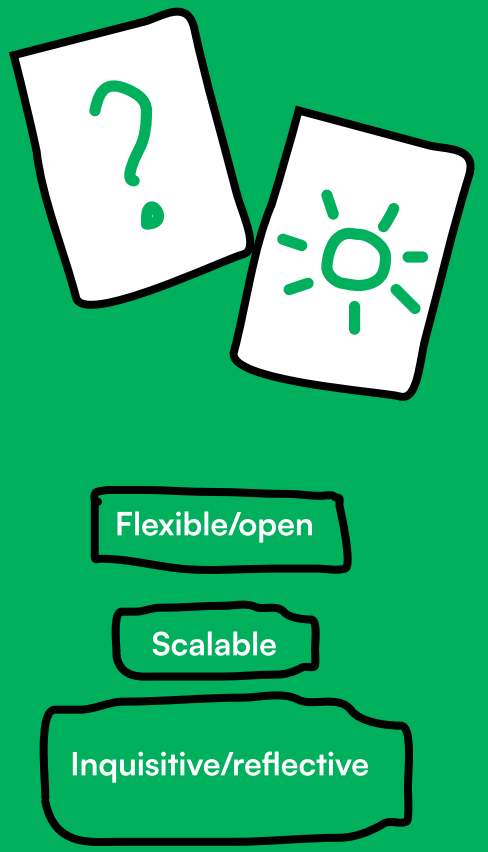
An essential prospect for simulations was to utilize some of the digital opportunities I discovered throughout the project. Simulations focus less on reproduction value, and more on potential.

Response systems

The second part of the framework, response systems, supports class instructions by acting mainly as inquisitive or reflective questions about a topic. One of their goals is to aid a teacher in scouting either prior or acquired knowledge of the group.

My subsequential ideation would search for ways to only change the method of response, which would lead to the question or theme, being open.

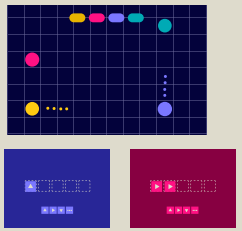
Unlike simulations, an important aspect of response systems was to offer both scale and flexibility.



Exploring simulations

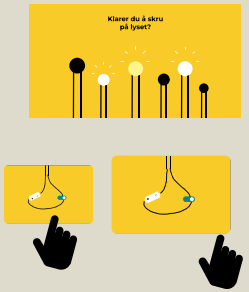
I used the science curriculum for 5th to 7th grade as a foundation for the simulations. I decided not to focus on scientific accuracy for every concept, in favor of exploring a wide variety of options.

In these ideas, the large squares represent a presenter screen, while the smaller ones act as the tablets.



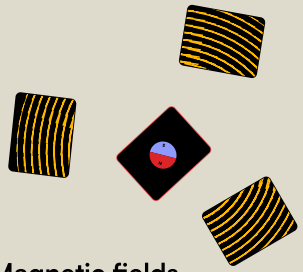
Vacuums

Learn to code by controlling vaccuum cleaners in a shared pac-man like game



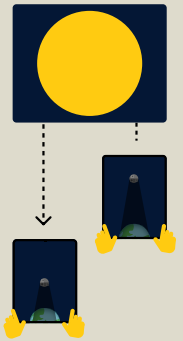
Circuits

Substance Shift



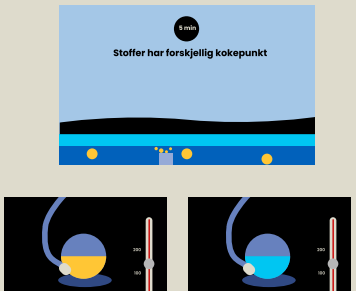
Magnetic fields

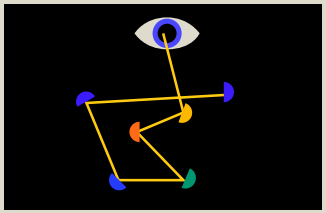
Spacial magnetic fields with 4 tablets

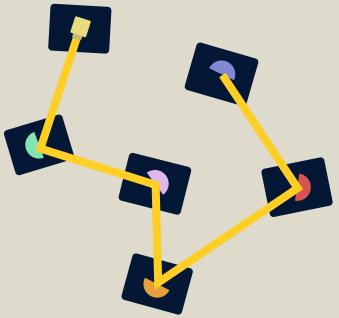


Why is the moon so large?

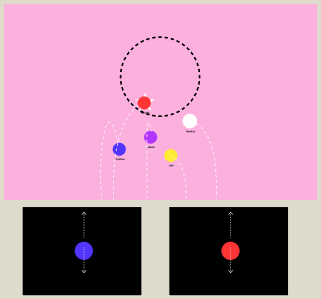
This example shows why the moon looks the same size as the sun. By moving closer and further from the screen.







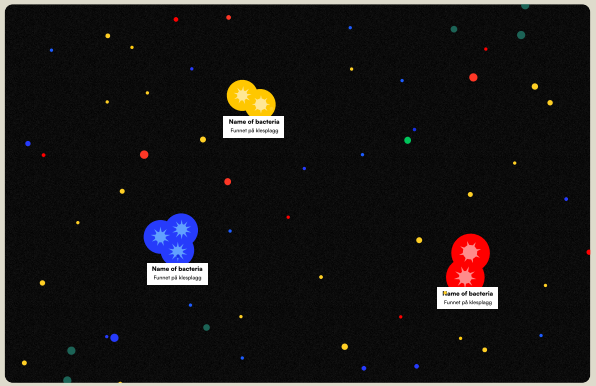
Reflections



Gravitational ball throw between screens

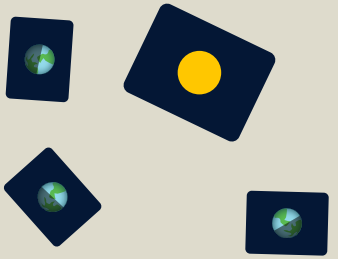
During the process, I discovered, that when combining spacial elements with scientific concepts there were numerous different options.

The framework forced me to think outside of the box, but subsequently generated many unique ideas.



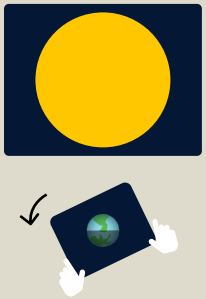
Bacteria discovery throug AR

In this bacteria simulation, pupils can use AR, and walk around the classroom to discover new bacteria. The device shows bacteria that live on different objects, such as people and spaces, operating similarly to a microscope.

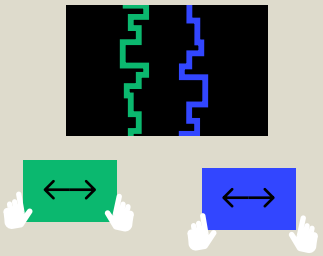


Day and night cycle

In this example the pupils can move around the sun, to see how a day and night cycle works.



The same example but with a twisting interaction

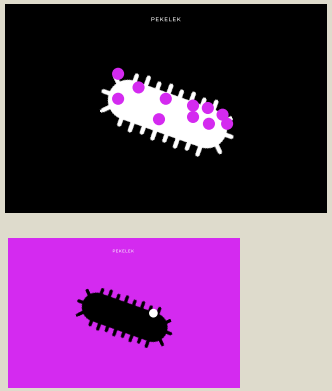


Wavelengths

Creating wavelengths by moving a tablet back and forth

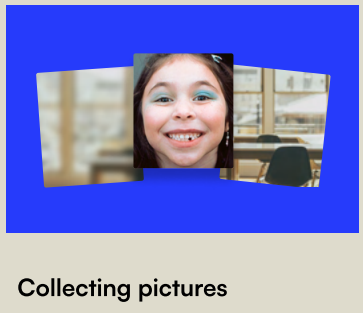
Exploring response systems

Response systems were explored through examples from scientific themes, however, their nature is to act open-ended.



Point it out

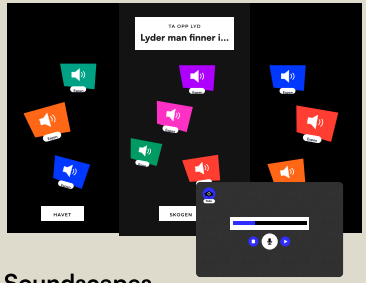
Collecting written answers



Collecting pictures

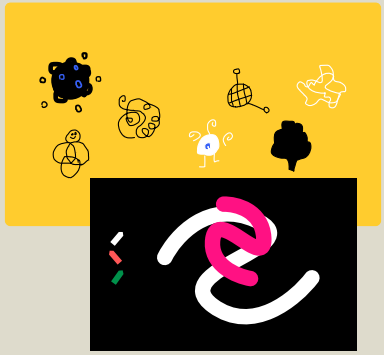
Answer combination

Here each participants gets a different way to respond, either by drawing, pointing or writing. A mixture of answers is pulled up on the screen

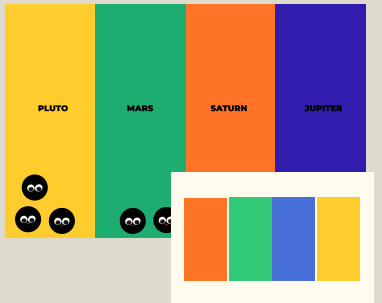


Soundscapes

Everyone records a sound which is then collected and played in paralell. What soundcapes can we create for a cave, a forest or inside a volcano?



Collecting drawings



Polls

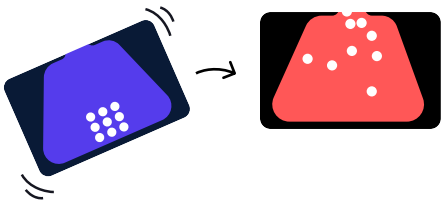
Multiple choice answers

Chosen examples

I chose three ideas from each part of the framework that would be tested and developed further. The choices were based on what suited the framework criteria, but also a shared set of criteria for both options.

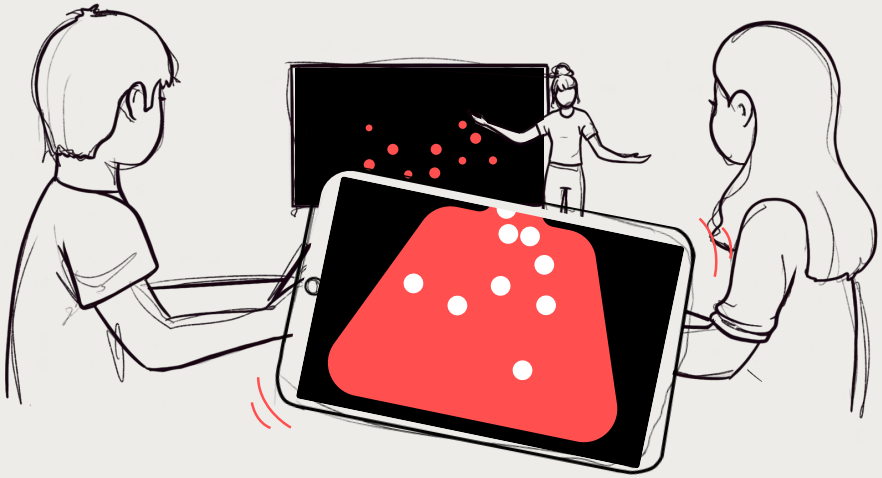
Shared Evaluation

- Social value in a large group setting
- Academic potential
- Engagement potential



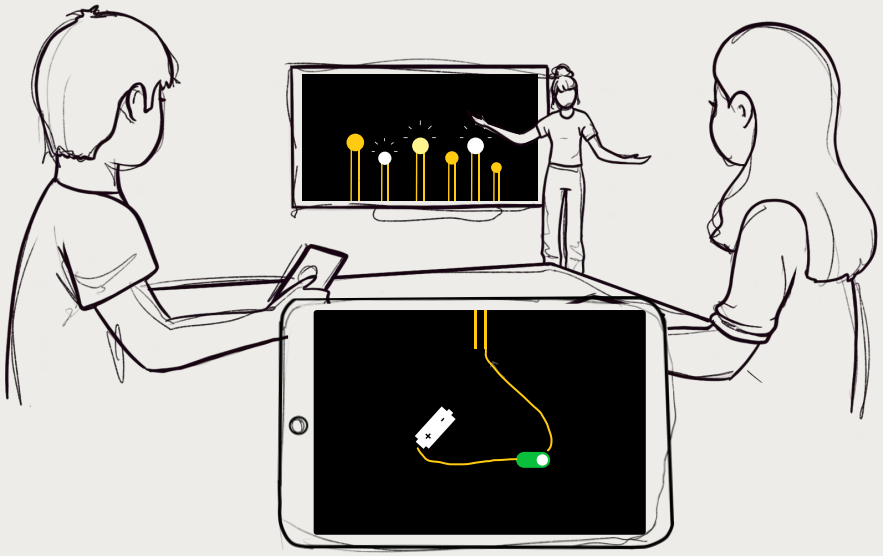
Substance Shift

The substance shift simulation, asks a group the following: “How can you turn this solid particle structure into a gas?”. The key is that by shaking, and in doing so- applying energy, the particles start to transition from solid, to liquid, to gas. When solved, particles corresponding to the pupils that solved it will appear on the secondary screen.



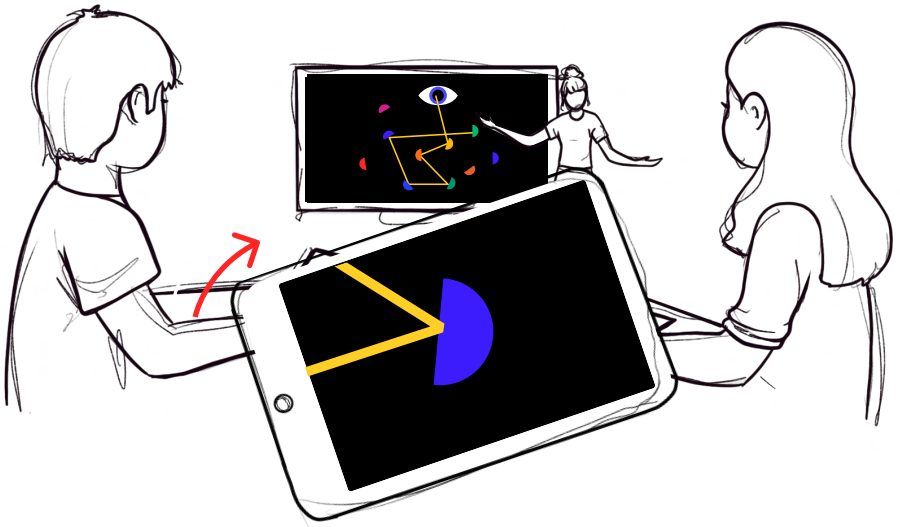
Circuit connection

In the second example, pupils are made to connect a circuit. They can complete the task by drawing connectors between existing components: A battery, and a switch. when successful, they each light an individual light, which can be seen on the secondary screen.



Reflections

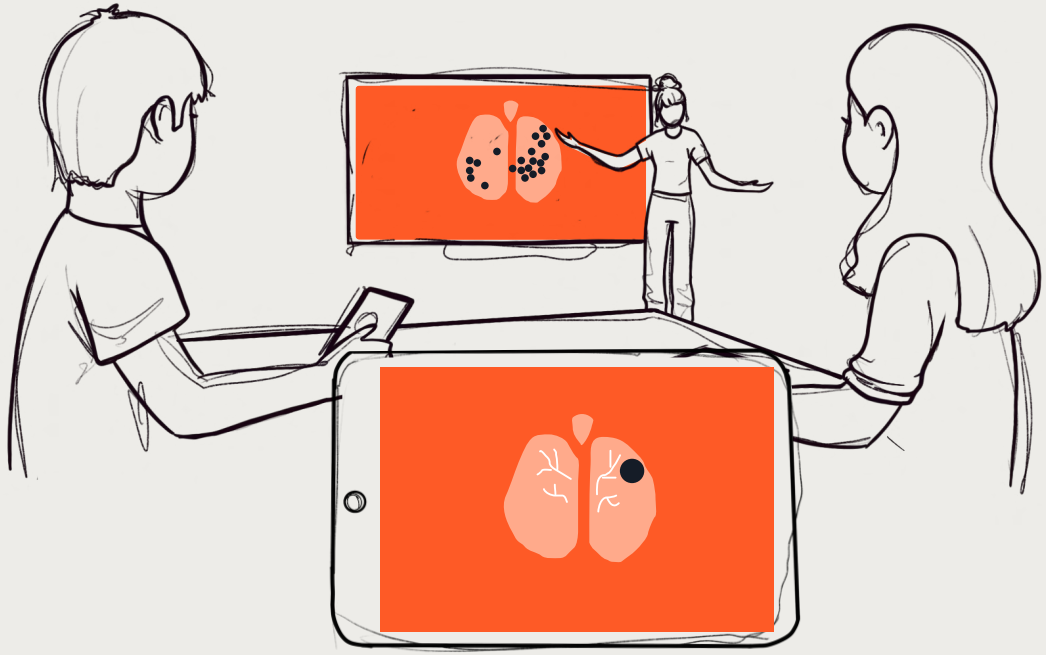
In this team work activity participants can make a beam of light hit an eye through the use of mirrors. By controlling a tablet and communication, they can solve the task together.



Response systems

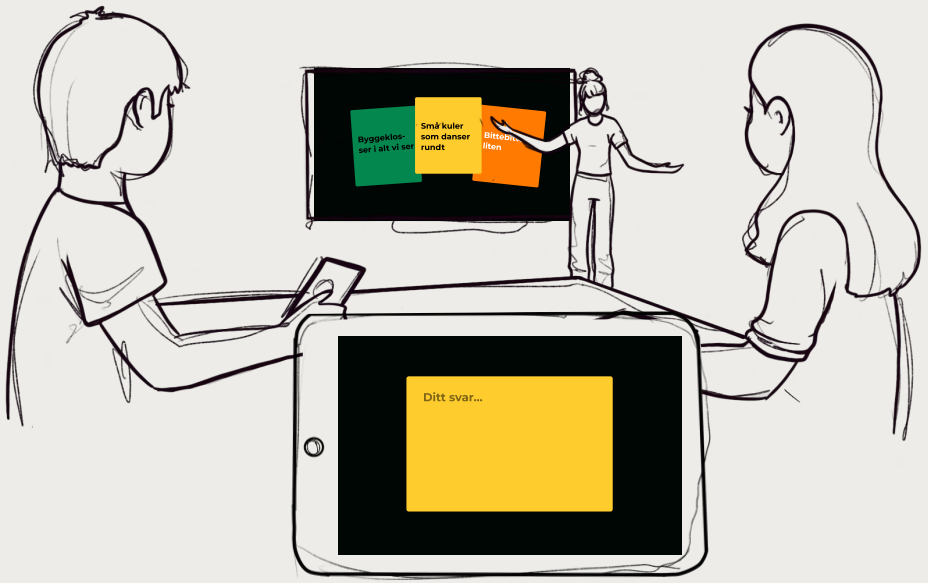
Point it out

In “Point it out” the way of response is through touch. By pointing at a specific area of an image, like a cell, a lung, or a map, every reply creates a heatmap on the secondary screen.



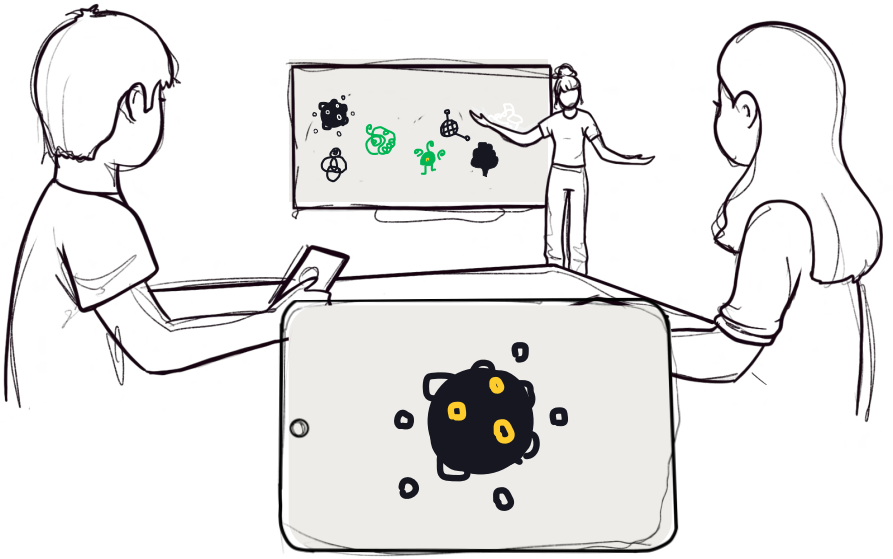
Question cards

Question cards incorporate a simple, yet relevant ways to gather group thoughts. Through a question, pupils write down their interpretation, which is then gathered on the other screen.



Think & Draw

Through “Think & Draw” pupils reply through a rapid drawing. This option is meant to be more suitable for open and conceptual questions such as “What does an atom look like?”.



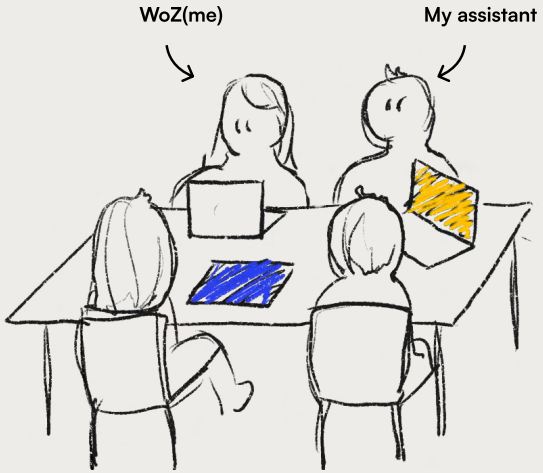
Testing

Setup

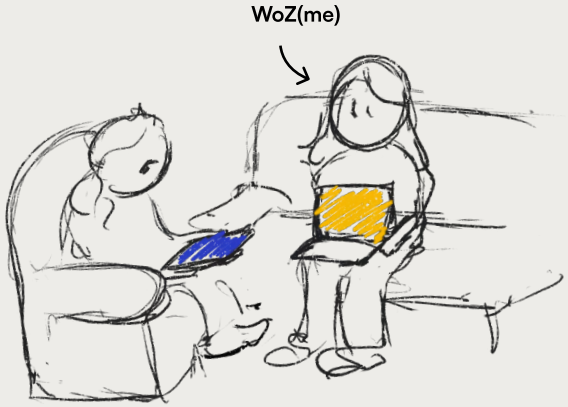
To test the concepts, I created a fictive lecture that would provide context to the solutions. The lecture was created in Figma pages, where I incorporated simulations and response systems in between.

This featured two different setups, one with an assistant presenter, and one without.

With the assistant setup, he was in charge of the slides and the monologue, while I observed and controlled what happened on the tablet. I conducted a couple of rounds of tests for both fifth graders and a 7th grader.



Test setup 1



Test setup 2

Simulations

To create a feeling of cooperating screens, I used the Wizard of Oz method to test the simulations. The WOZ method refers to a system controlled by a human operator but is believed to be autonomous (Geison,2019).

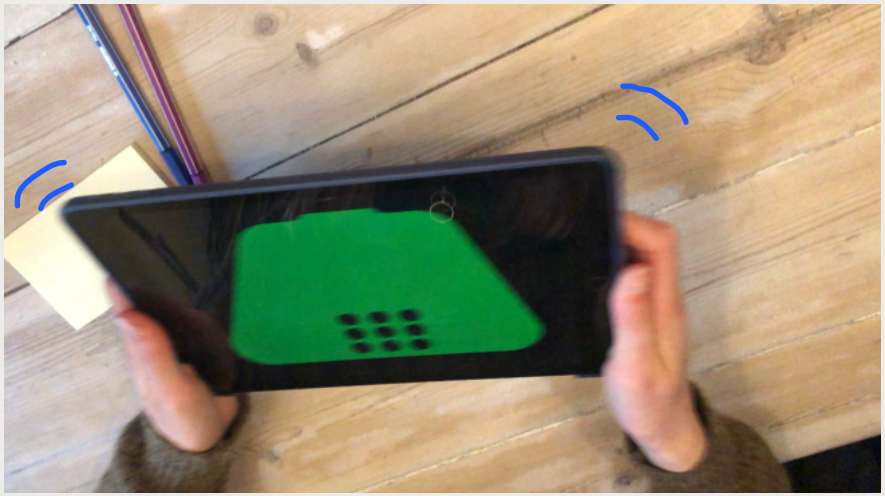
I found this method useful, as it allowed the concepts to come forward in a close-to-realistic way.

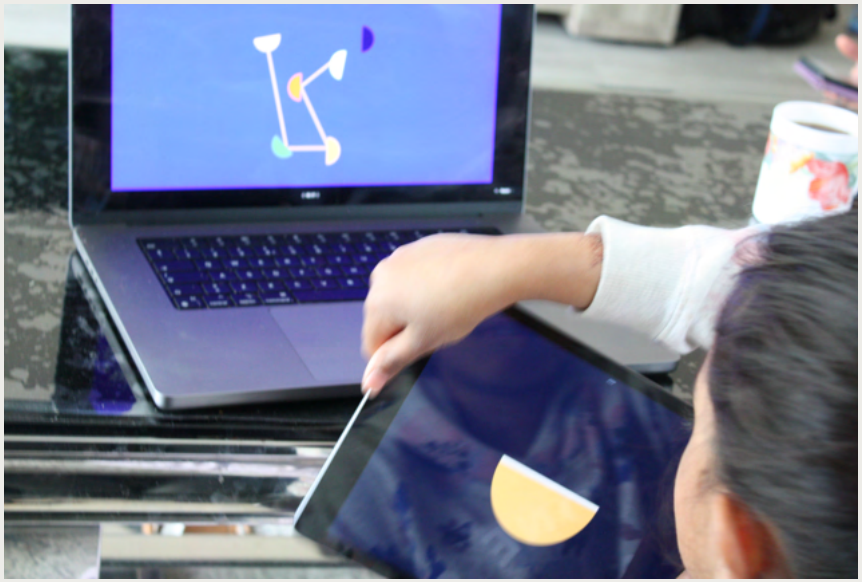
The use of an assistant was helpful by allowing me to observe the circumstances from an outside perspective. This also provided additional findings regarding the facilitator role.

Takeaways

- There was a lack of personalisation/ recognition.
- The support role was needed, though there was a lack of aid in knowing how to.
- “Reflections” needed a better solution for many participants, in order to avoid complications.

→ **Changed “Reflections” to a split screen solution**

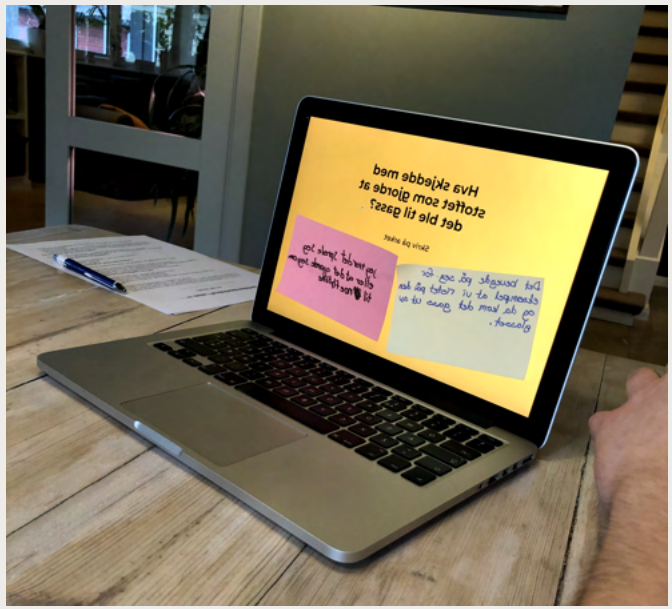




Response systems

To test the response systems I used a workaround with post its as replies.

The method lacked the feeling of a responsive system, however it helped to better get a sense of time use, how they interpreted the tasks, and lastly how the assistant would leverage or struggle with them.



Takeaways

- The interpretations were varied and unexpexted
- There was confusion surrounding how much time to spend on an answer.
- “Think & draw” felt in part isolating.

→ **Changed “Think & draw” to a shared drawing board solution.**

Limitations

The pitfall of these methods is their inaccuracy with the real experience. With that in mind, it is important to mention some of the limitations that come with the complexity of the solution. Cooperative screens, animated elements, multiple devices, and participants, limited the options of my testing methods. The ideal way of testing such a system would be with the aid of developers and in a larger group setting.

Measures

Based on learnings from the tests I created a set of pointers that I used for further iterations and development of the final concept. They are based three important teacher support roles when it comes to the use of digital technology in the classroom (Furberg, 2015, pp.17).

Conceptual

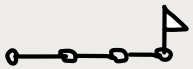
How can a teacher build on the activity or elaborate on the task?

How does an activity relate to the content on a conceptual level?

Social

How does a collaborative task work on an organizaitional level?

How can a teacher support and regulate a social activity?



Procedural

How does a participant know how long to work on an activity?

How does a participant know how to organize and plan for performing an activity?

How can a teacher to observe and follow up the pupil?

06.

DEVELOPMENT

Creating a shared system

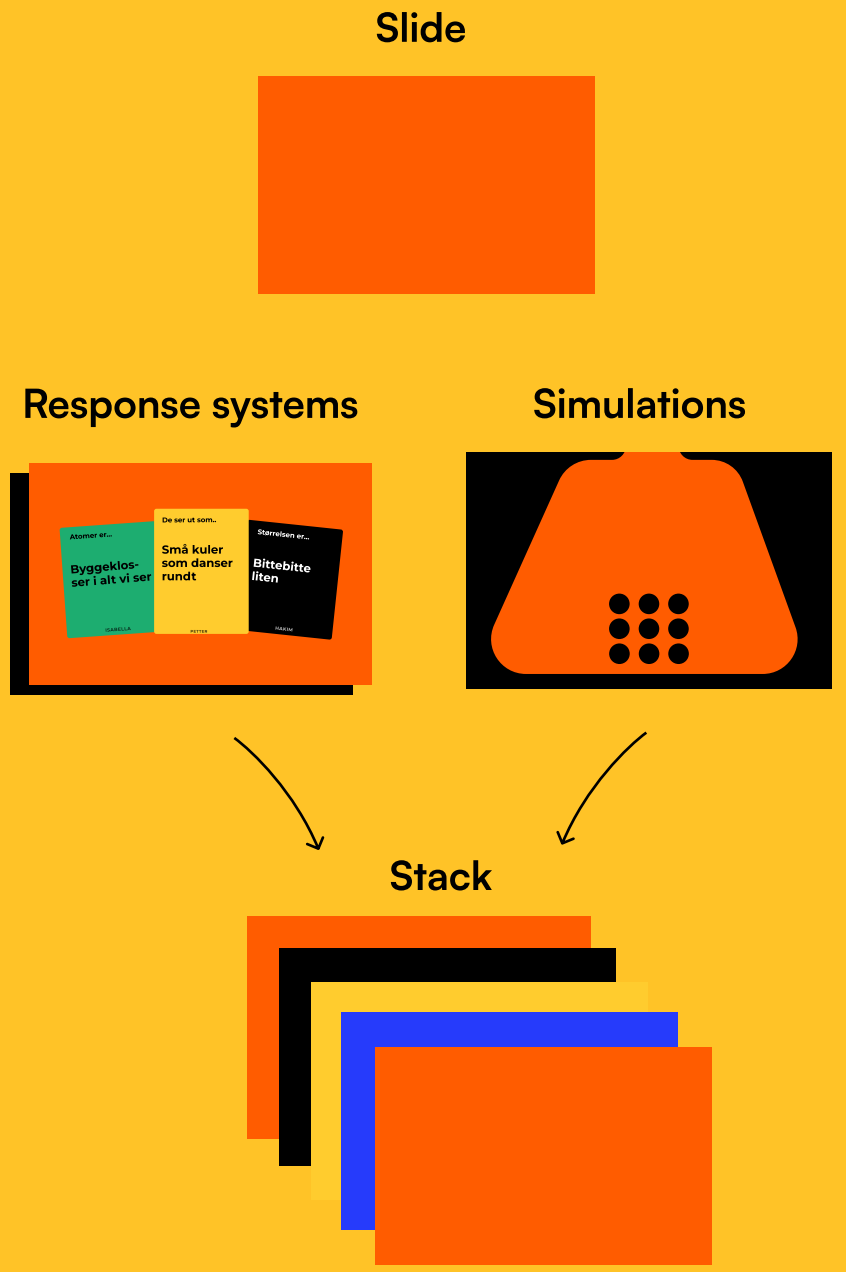
Stacks

To put both parts of the framework into their intended context, the idea was to create a shared composition called “stacks”.

The role of stacks is to work as presentation-like sequences that include response systems, simulations, and non-interactive informational cards. Cards would work similarly to a regular presentation slide.

The role of a stack is to act as a sequence of simulations, response systems, and context, with a thought-out progression path.

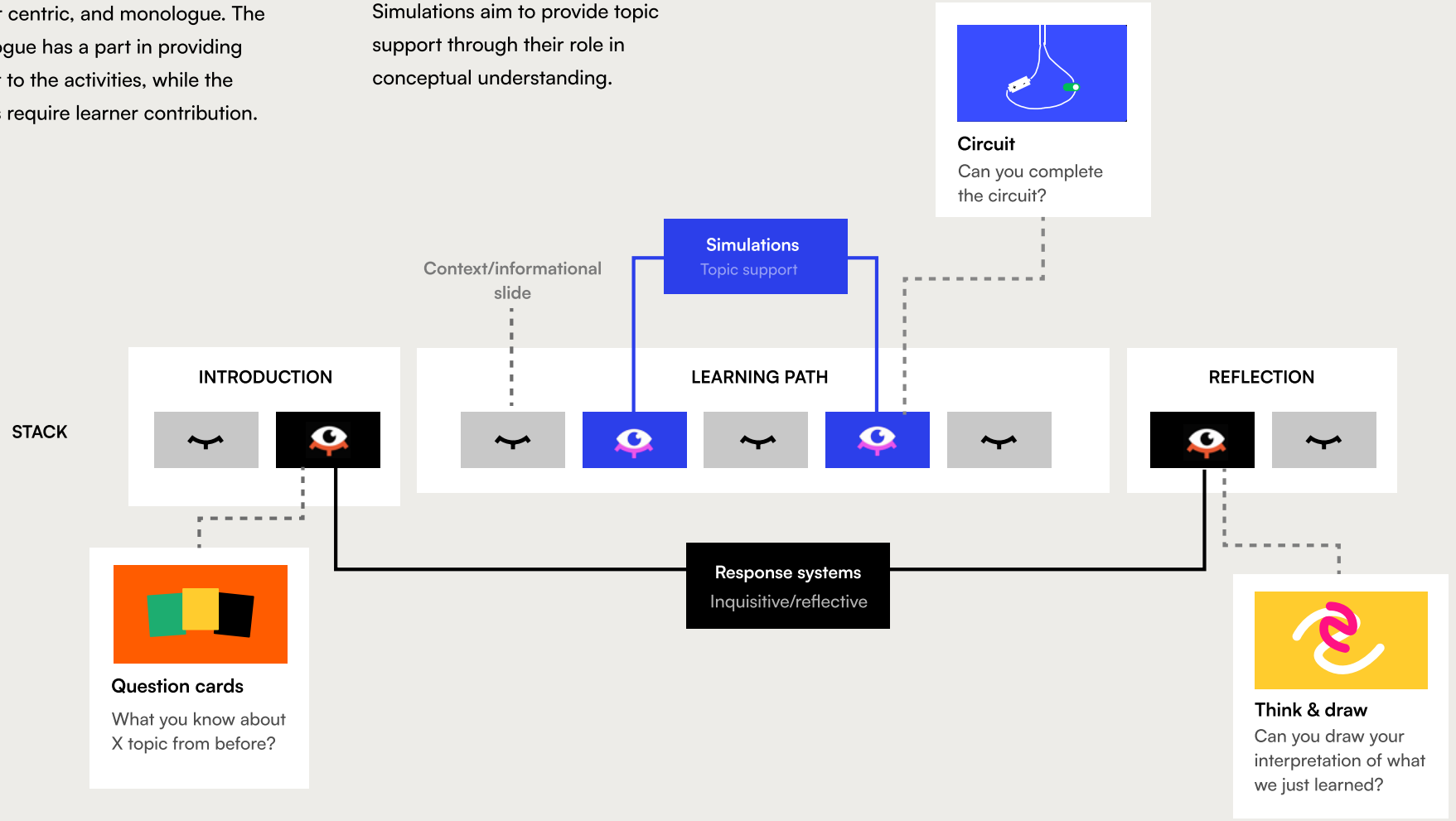
Further, I will refer to response systems, and simulations collectively as “activities”, however, they are not the same as a stack, which is a composition including the two.



Stack progression

Response systems and simulations each have a role in a stack. They work as active learning in between inactive, teacher centric, and monologue. The monologue has a part in providing context to the activities, while the activies require learner contribution.

Response systems provide the inquisitive or reflective questions at the end or beginning of a new topic. Simulations aim to provide topic support through their role in conceptual understanding.

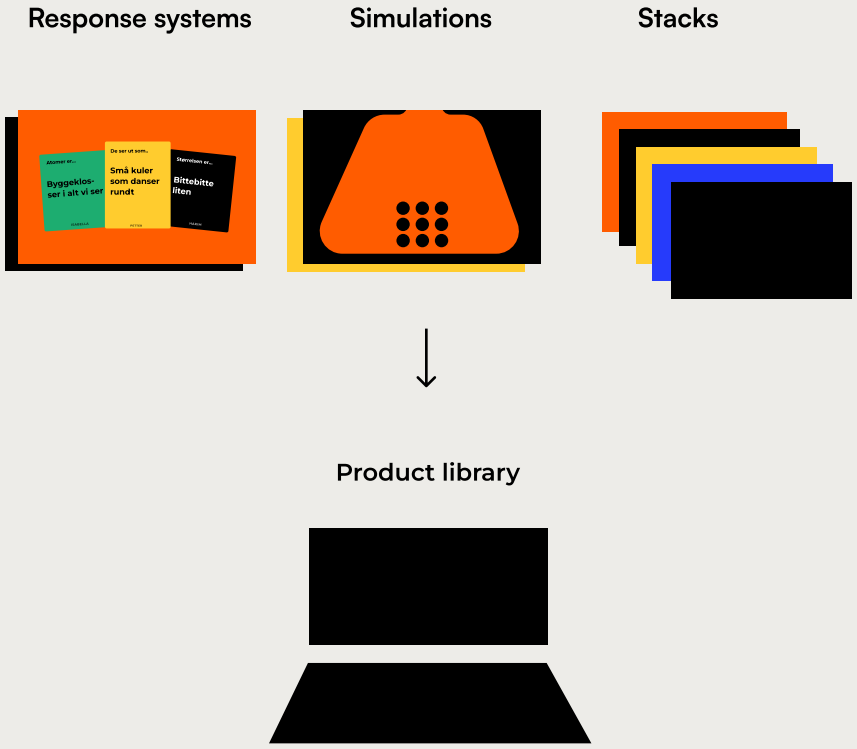


Core pages

In continuation, I looked for ways to give the ideas a practical use by incorporating them into a shared system. I started iterating on parts of a design system and a platform library encompassing all three parts of the solution.

This began with wireframes and later to conceptual sketches and semi-clickable prototypes. Iterations were made based on a series of feedback sessions with a couple of teachers. They were urged to click through the main pages and think aloud.

Further, I will elaborate on some of the decisions and iterations.



Entry Lobby

For screens to cooperate, there is a need for a connection or link between them. I started sketching a solution for an entry lobby, where teachers could invite pupils to attend.

Through the feedback sessions, one of the main changes was the decision of a QR-code entry point, with the addition of a number as a backup code. With the benefit of built-in cameras on tablets in mind, this proved to be the most effective entry point.

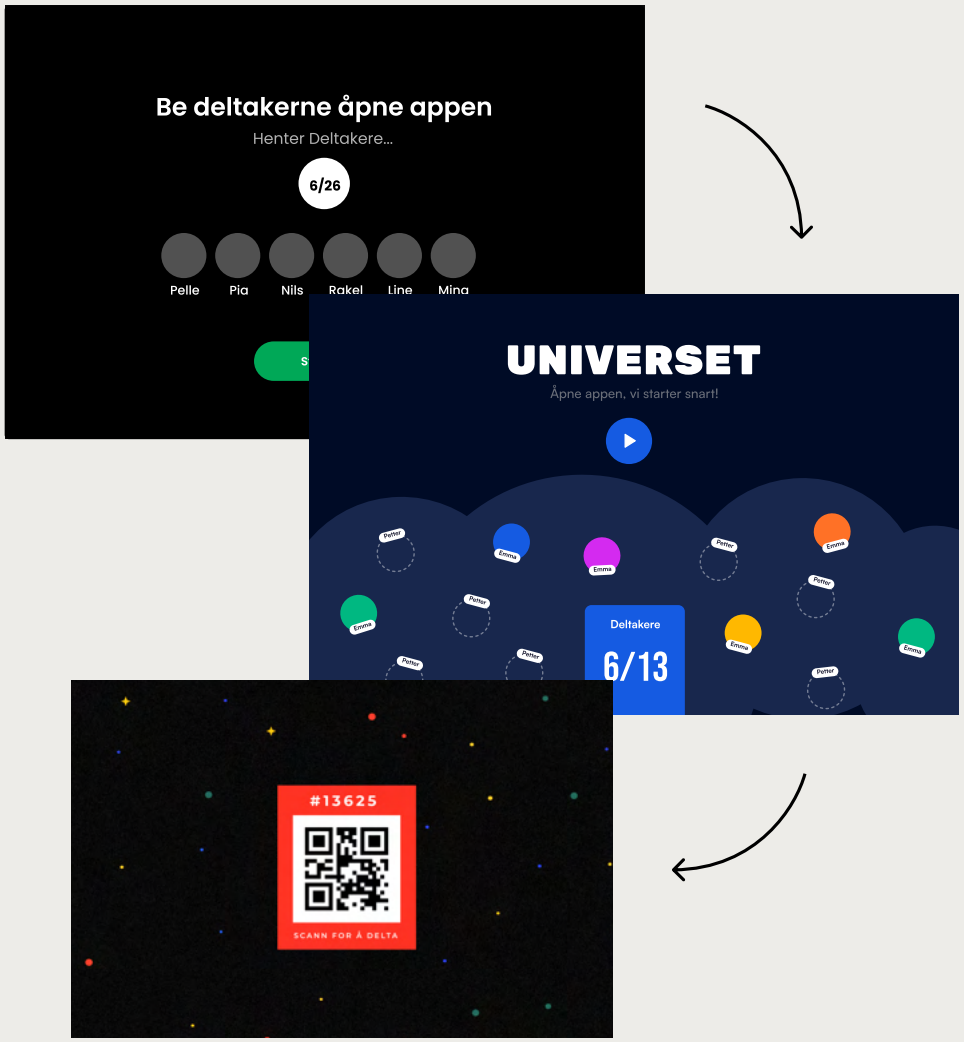
Main iterations

A whole class trying to log in every time one uses the solution can be a problem

→ **Changed invite, to QR code**

Waiting boredom

→ **Created a more engaging display**



Library

In order to encompass the potentially broad range of activities and stacks, I iterated on a content library. The main feedback was on the structural elements of the solution, which resulted in the most significant iterations.

Main iterations

The most inviting content were simulations

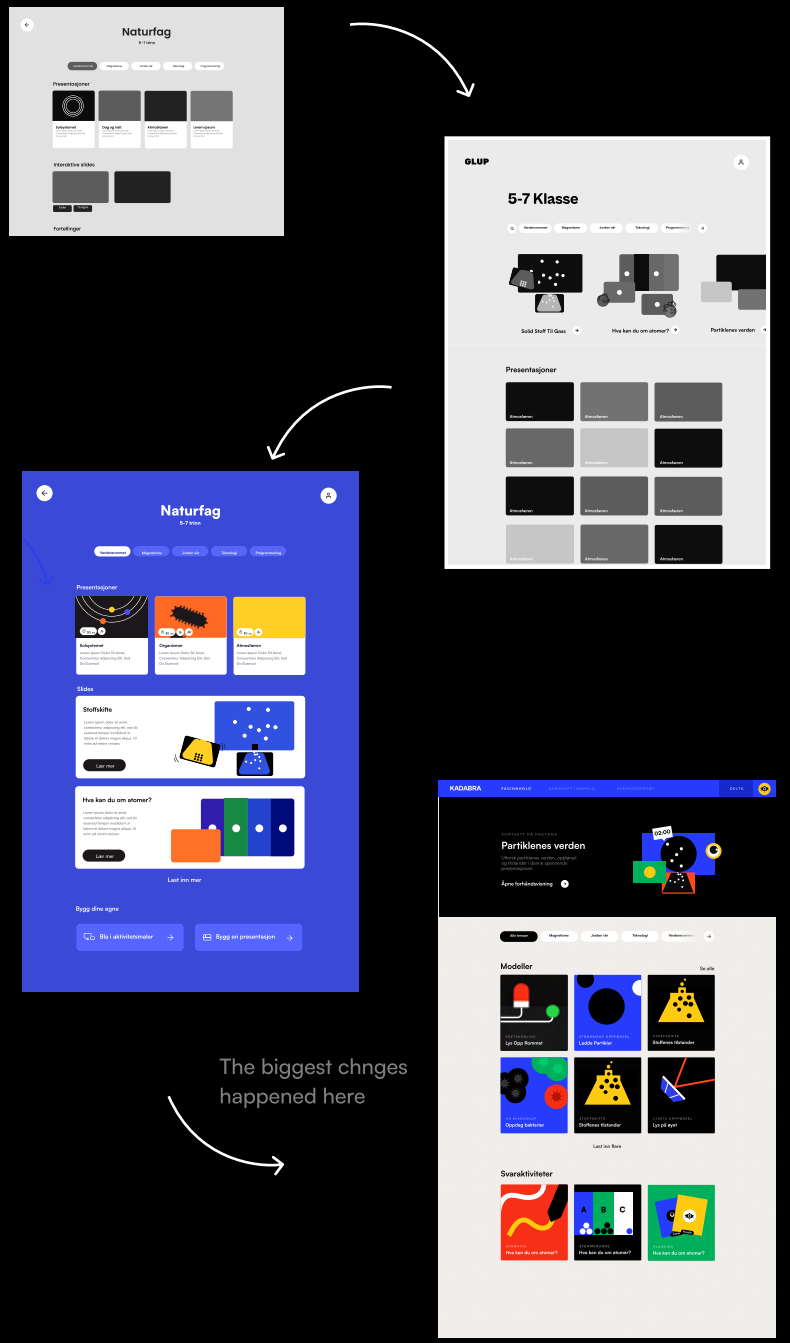
→ **Moved to the top**

Difficult to know where to begin

→ **Added suggested content**

Too much to read

→ **Moved the text to instead appear in a pop up when clicking on an activity**



Presenter display

With multiple displays, participants, and things happening at once, the earlier tests proved that there was a need to support teaching and facilitation. This pain-point led me to the solution of a presenter display.

The main decisions were regarding extra needed teacher support and simplification.

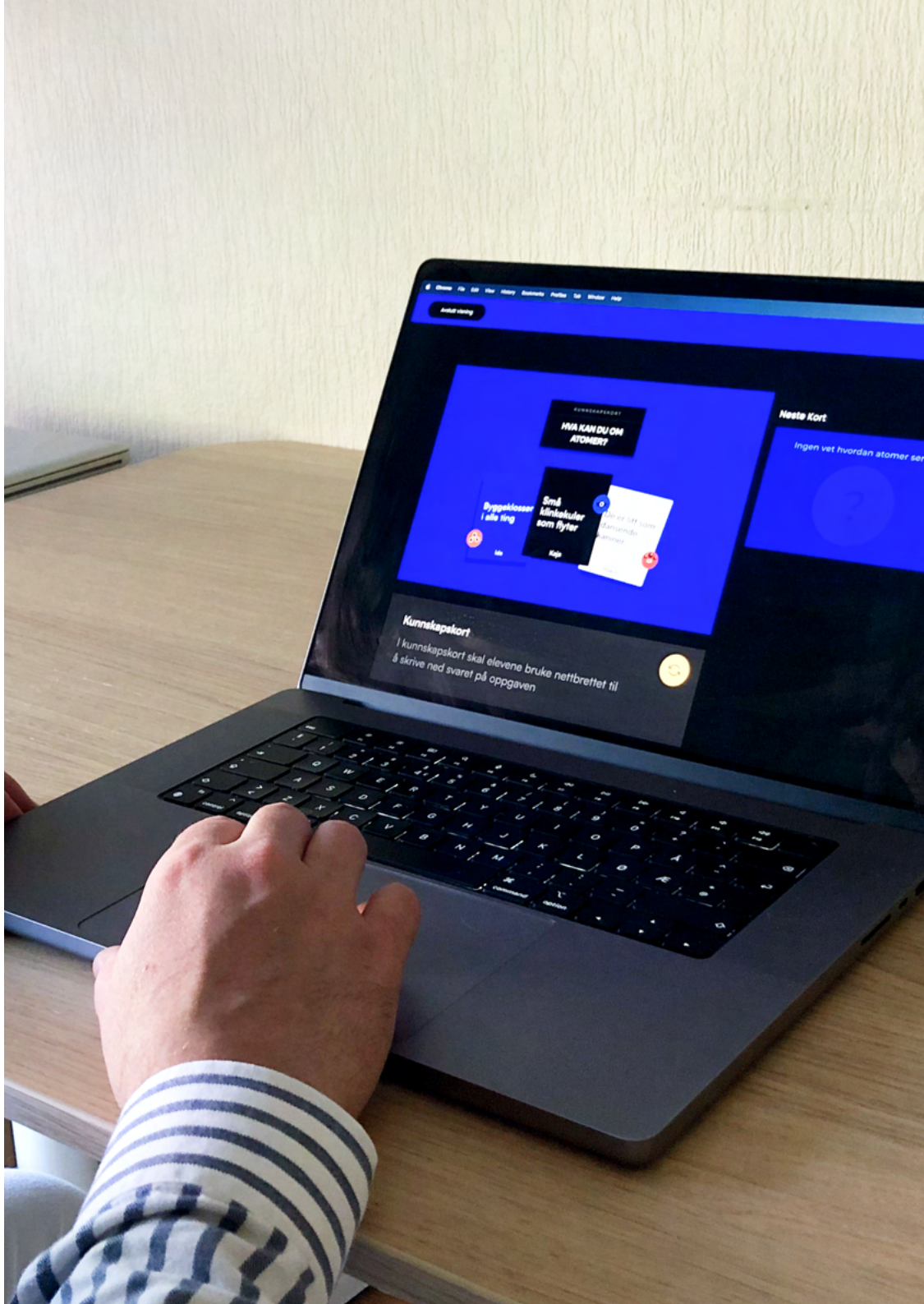
Main iterations

Teacher support appeared important when it came produced content

→ **Added support notes**

Wish for a status overview, e.g. the amount of answers collected.

→ **Added toolbar for status, and other task options**



Design elements

The next part of the process was to create certain elements that could work as proposed components for the different types of activities.

Activity components

With the aid of the prior tests, as well as technical projector tests, I iterated my way through a number of components and elements.

Main decisions

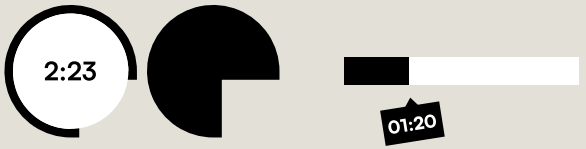
When you are at the back of the class, it is hard to see the bottom of the screen

→ **Attached important information to the top and in contrasting colors to the background**

When a class contains many students, it can be hard to differenciate each one

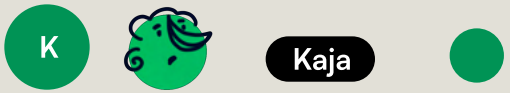
→ **Created system for levels of personalisation**

Time indicatiors



Descriptions and labels

Personalisation



Answer system

To differentiate five, ten or even fifty participants at one time, there was a call for a system of identification.

The system would ensure that each participant could identify their own screen activity based on a scale of recognition.

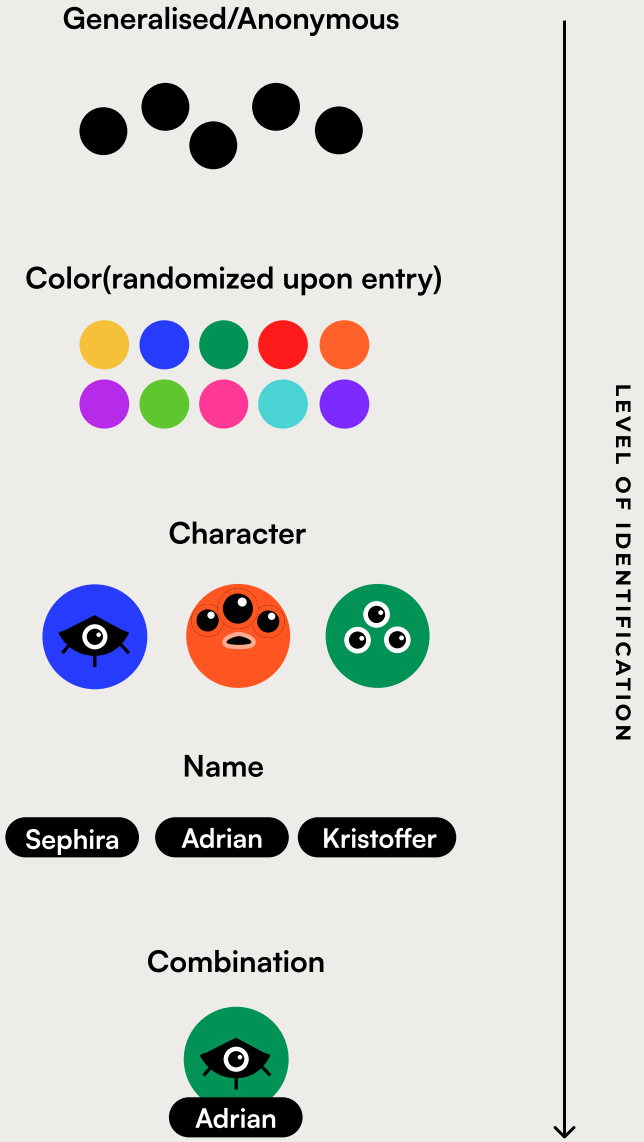
Feeback also suggested that some of the activities drew more benefit from anonymity than others. Based on that, identification would follow certain guidelines highlighted below.

High levels of identification suit if:

- Identification does not result in a negative experience. E.g. it highlights when someone is struggling or is slow on a task
- An activity displays only a select amount of answers at one time, as to not create confusion and cognitive overload.

Low levels of identification suit if:

- Identification does not add any value to the task, I.e. a heatmap
- There are numerous answers presented on the screen



Branding explorations

I explored different branding options for the solution, where the main inspiration was a play on attention or active and inactive learning states. The logo features an eye that reflects that idea, as well as the characters.

The graphic style and branding also drew a lot of inspiration from the science topic, with the mystery and wonder of space as the main inspiration.

Kadabra as a brand

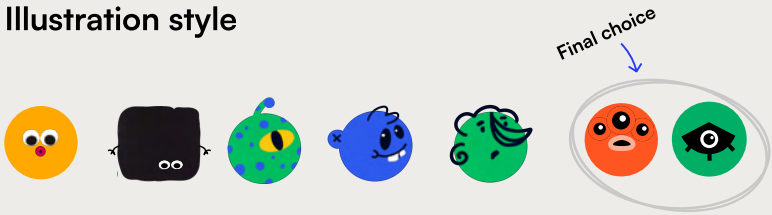
Graphic style

- Geometry, symmetry
- Mystery, space, wonder, science

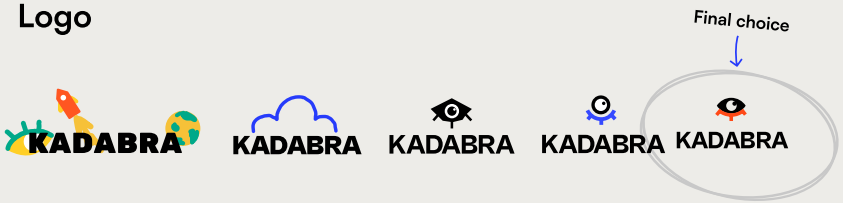
Tone of voice

- Energetic, but not hyper
- Encouraging, yet understanding

Illustration style



Logo



Colors in context

06.

FINAL CONCEPT

Scope

In order to communicate the core idea of the concept, I created the core pages, as well as thoughts behind other features that should be expected.

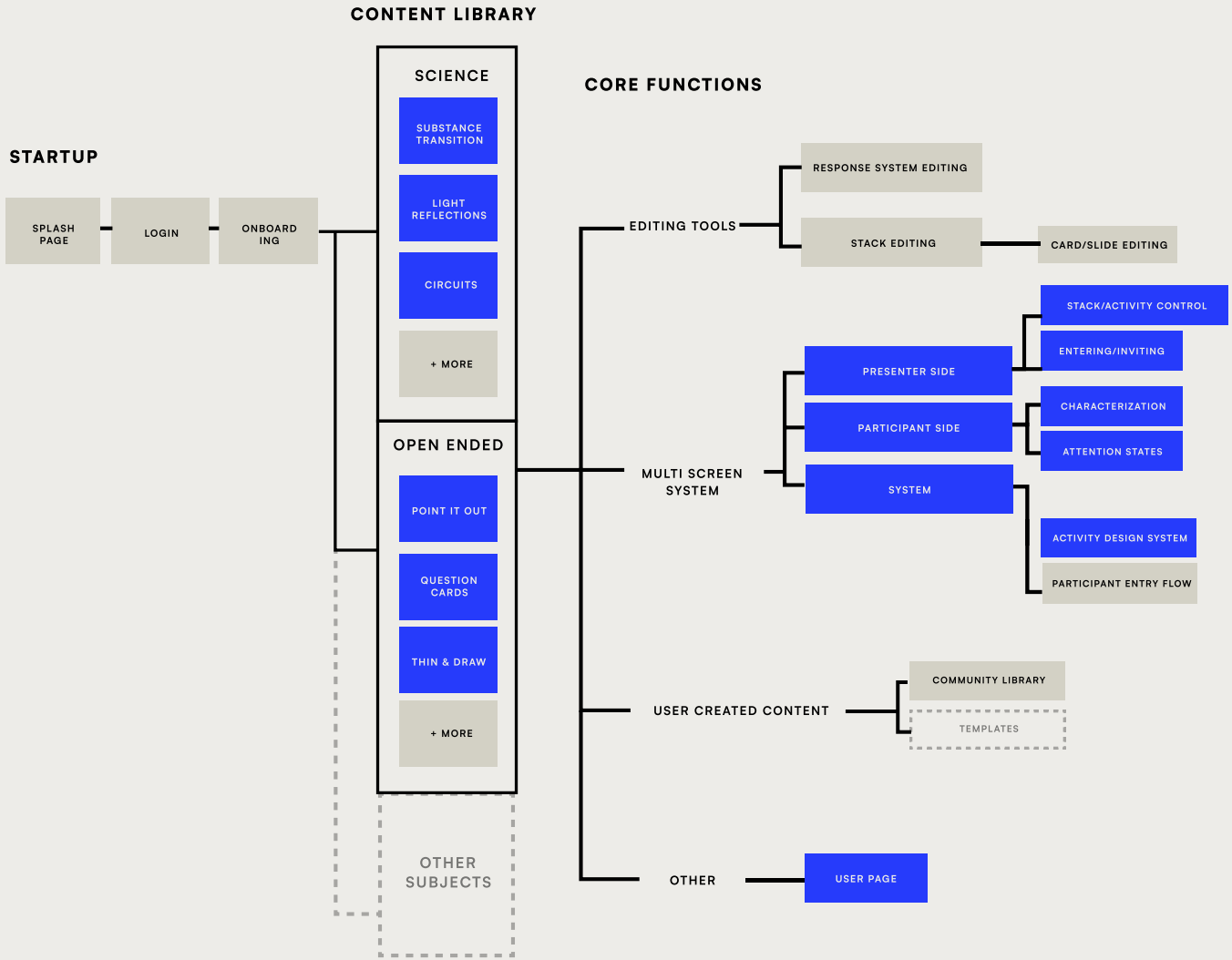
Some features have been made room for, like editing tools, and a community library, but are not focal elements of the solution.

My aim was to highlighting the unique offerings and features that the concept provides.

WHAT I DESIGNED

WHAT I PROPOSE

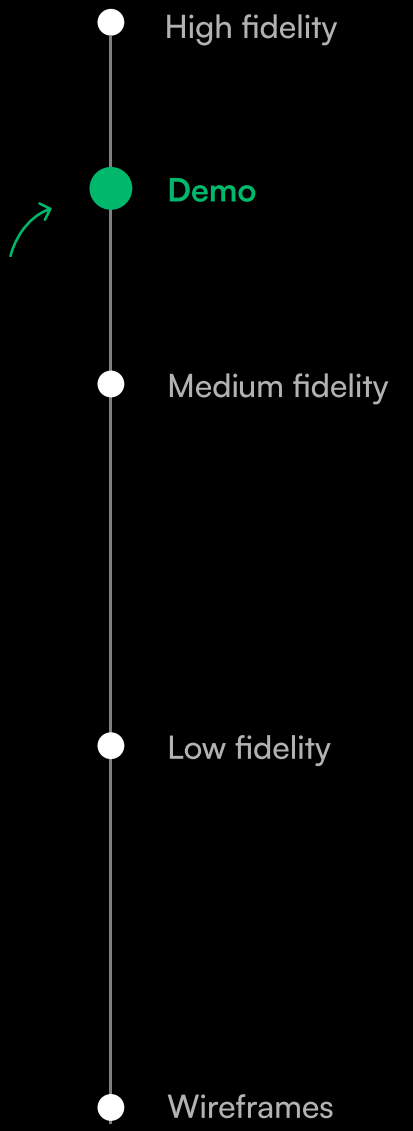
POTENTIAL BEYOND SCOPE



Prototype

Compared to high fidelity, which can be considered a high level of detail and transitions, my prototypes can be regarded as a demo. In order to demonstrate several parts of the solution, I chose to create a final-looking result, not including the finer details of a finished product.

Additionally, the project does not take into account business models, but I chose to build on a model that fits within the current purchasing scheme.



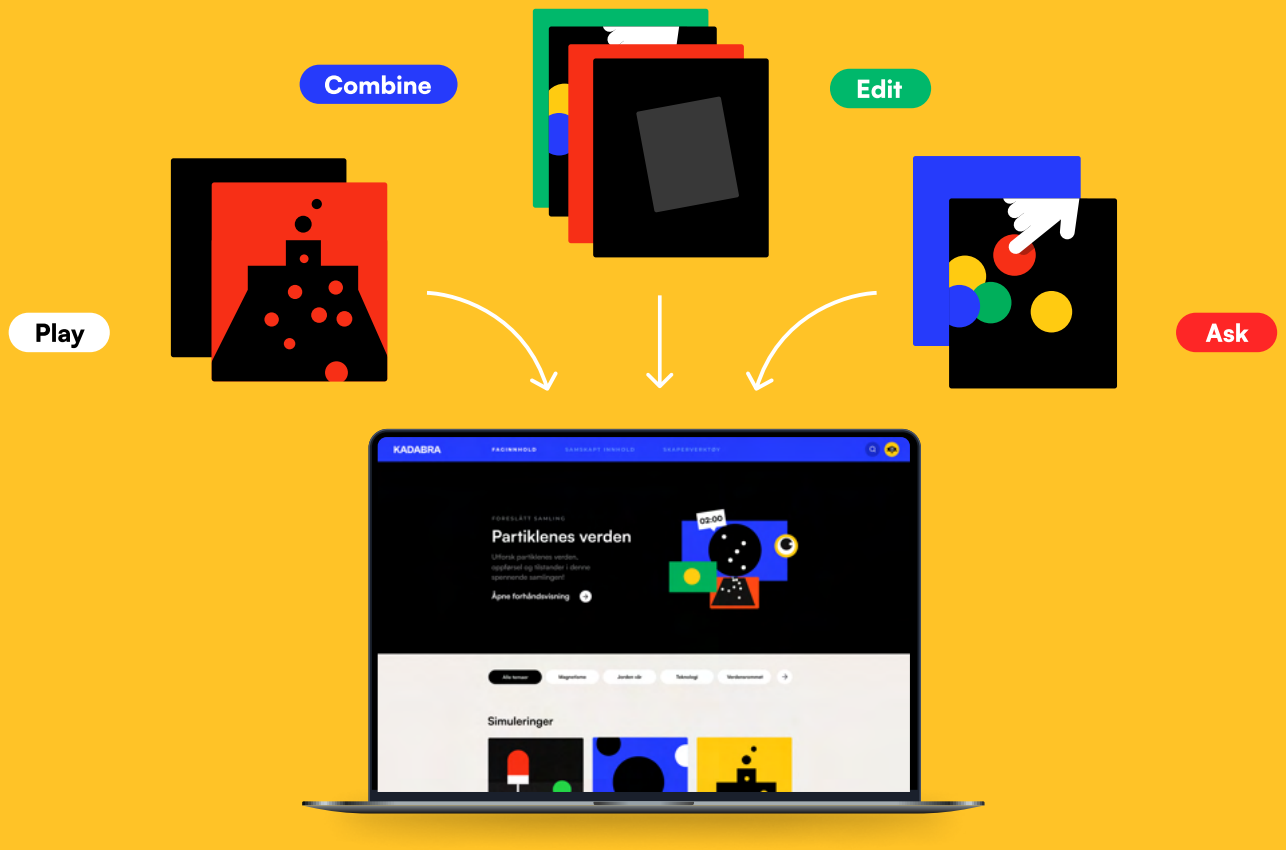
KADABRA

Introducing Kadabra

Kadabra takes on learning through an active and flexible approach with broad and engaging learning experiences, acting on multiple devices in the classroom.

It’s a library for running wide-ranging educational and playful content

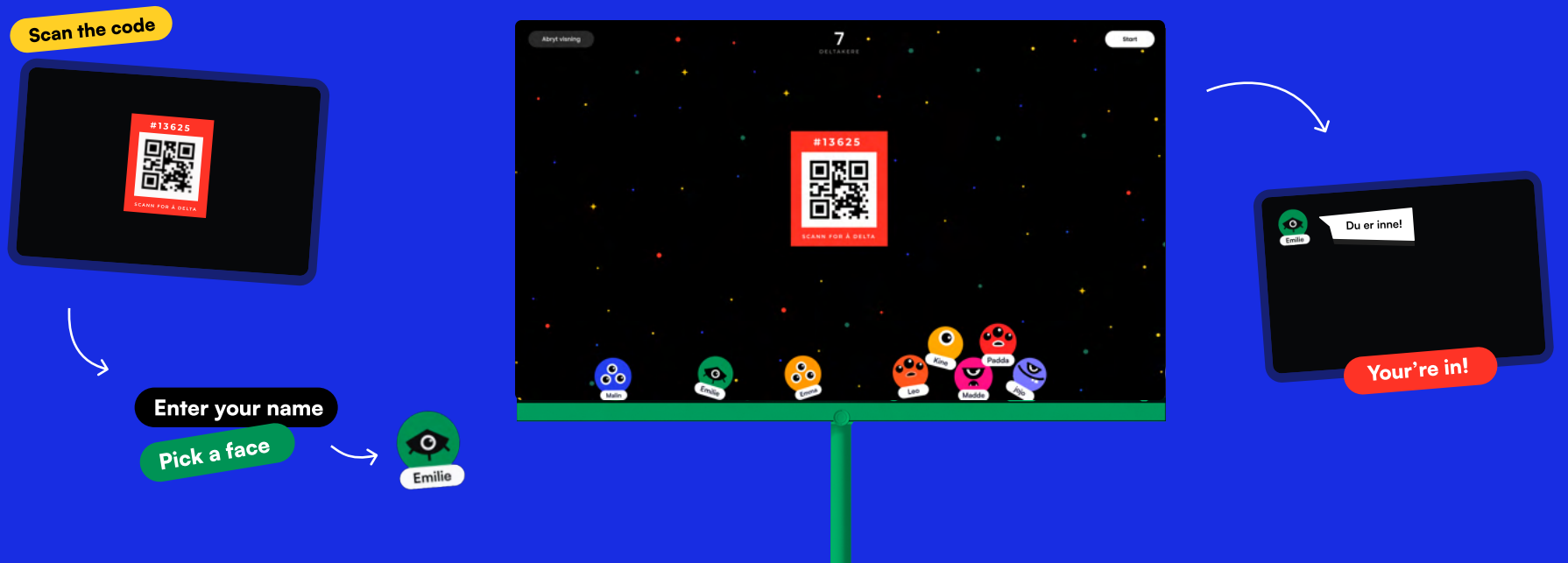
When it comes to produced content, Kadabra intends to consist of a variety of simulations, flexible response activities, and combined stacks. The product would also include additional content created by its user community.



How to enter

When launching an activity, or a stack, participants can enter by scanning the QR-code on the screen.

Upon entering, the participants get a random color, and input their name, as well as pick a character face. The character tumbles down from the top of the screen, indicating that they are now in the waiting room.

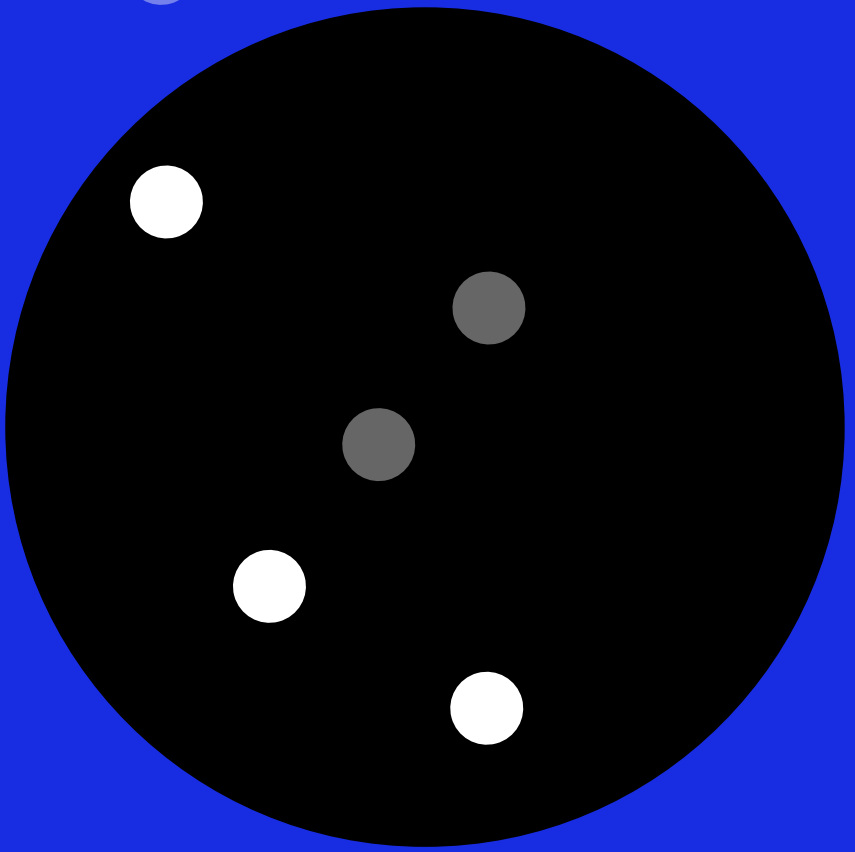


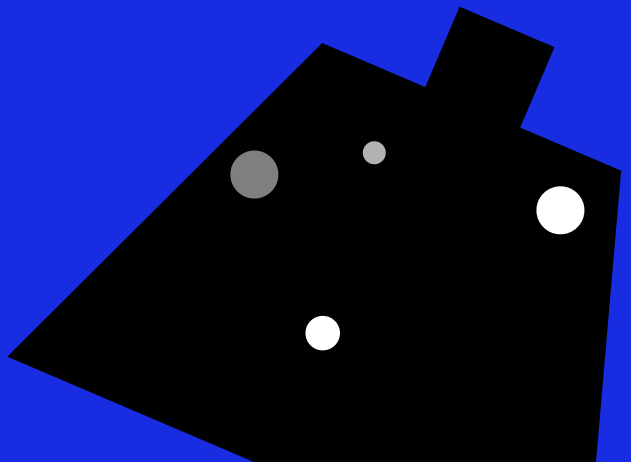
Activities

The examples that are included aim to show simple solutions that exist within a larger library of possible content. Here, the core ideas and sequence are shown, but like the rest of the prototypes, the micro interactions and technicalities are not a focus of this project. Further, I provide examples, of simulations that can exist within the library of Kadabra.

Simulations

There are a number of new ways to learn scientific concepts in social ways, and simulations aim demonstrate just that. They support conceptual learning through the use of abstracted, and explorable social activities.





Substance shift

“Substance Shift” aims to teach learners about particle structures by asking “Can you turn this solid into gas?”.

The trick is to turn heat, into energy by utilizing movement. When shaking the tablet the particle structures begin to shift, and gas will start to emerge on the shared screen.

Every participant has a dedicated color, and the particles that appear will begin to show up in numerous colors, as more people solve the task.

This example utilizes accelerometers, which make it possible to detect shaking, movement and rotation.

Before shake

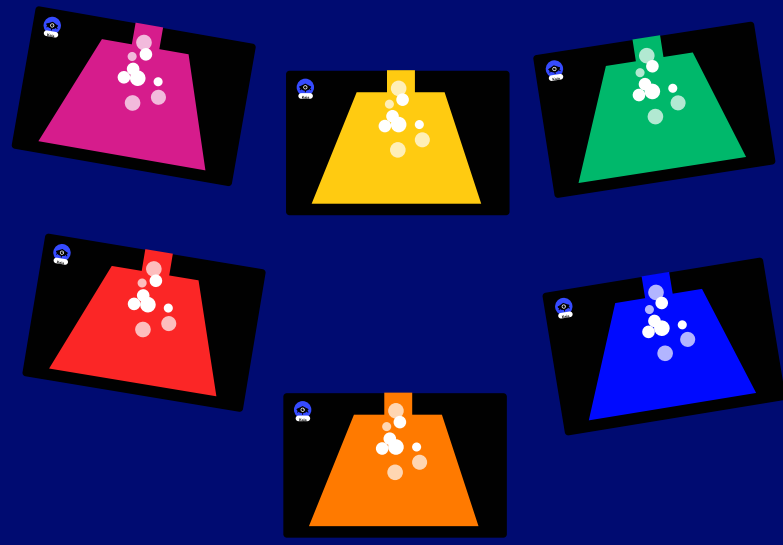
After shake

Gas

Liquid

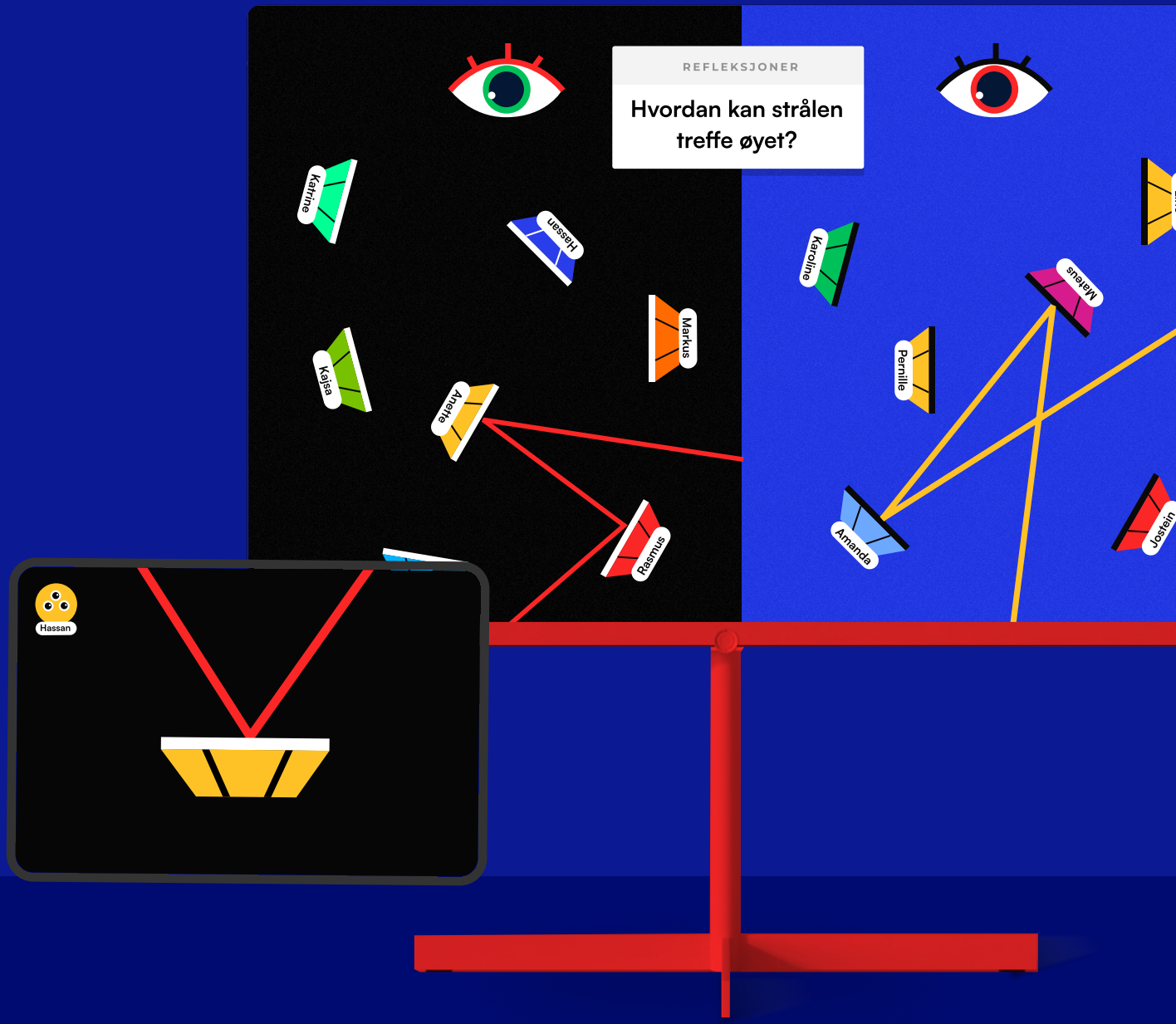
Solid

In context

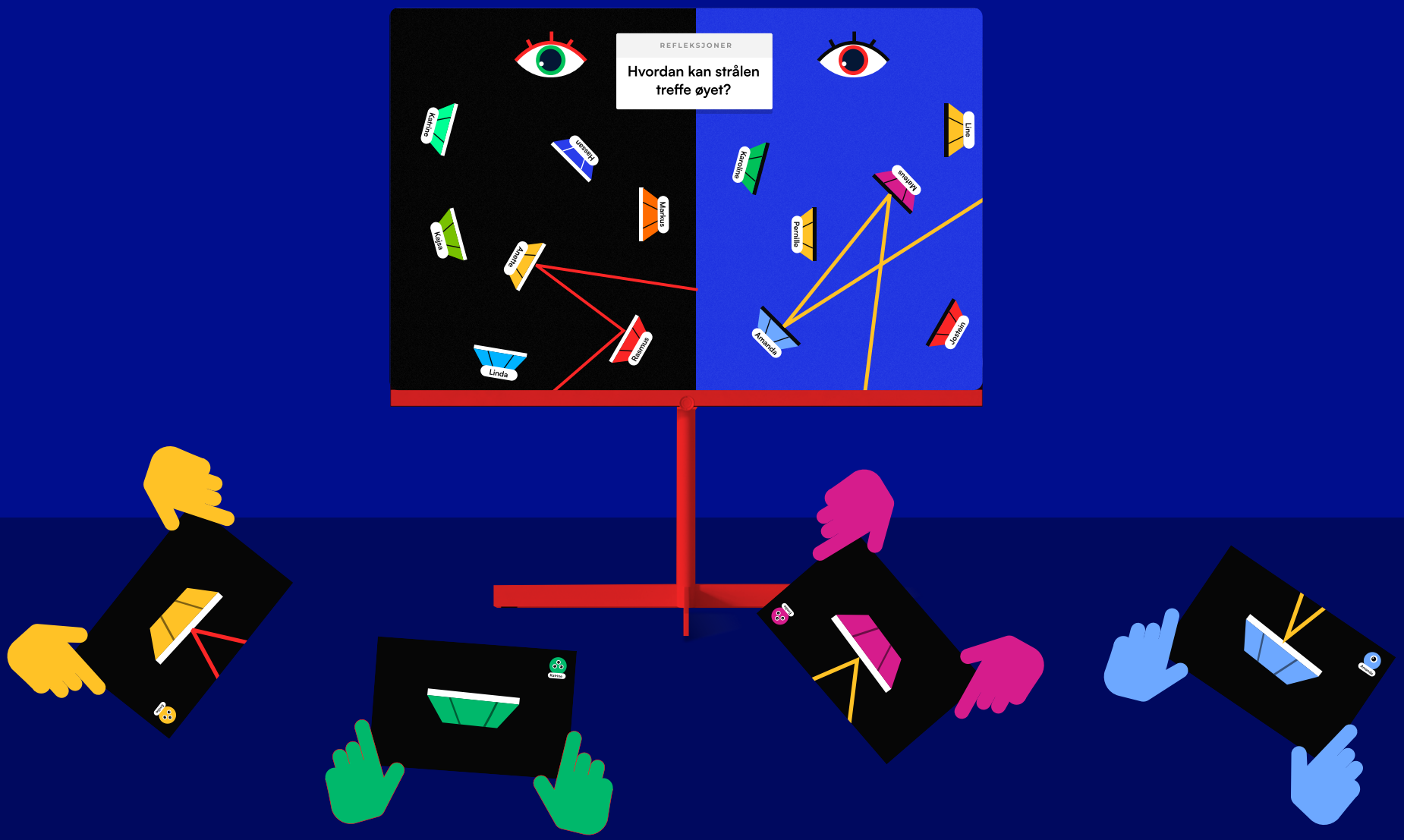


Reflections

This simulation is all about teamwork and logical thinking. The group is called to collaborate, in order to make the beam of light, hit an eye. Through careful coordination and teacher guidance, participants can successfully solve the task.

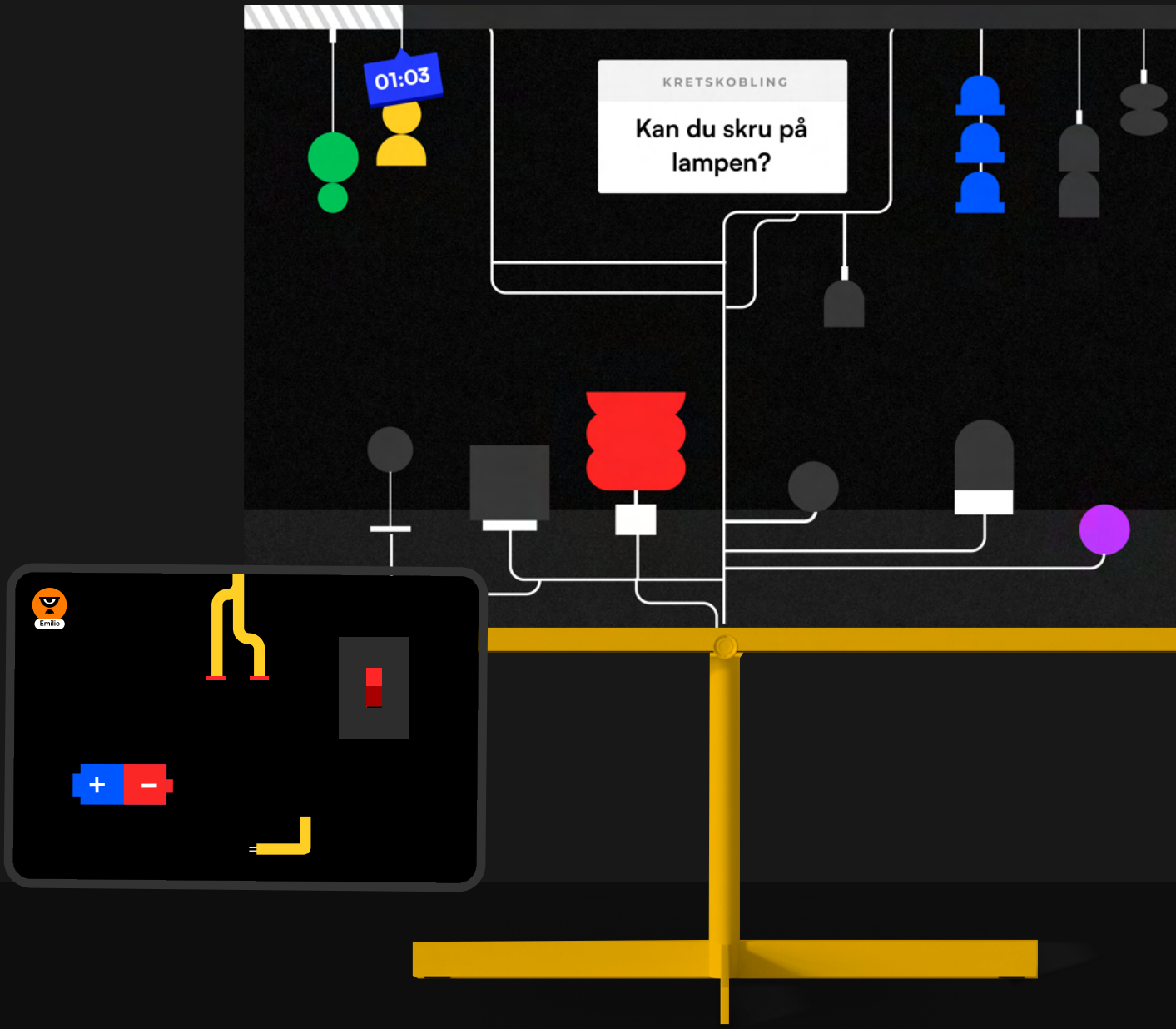


In context

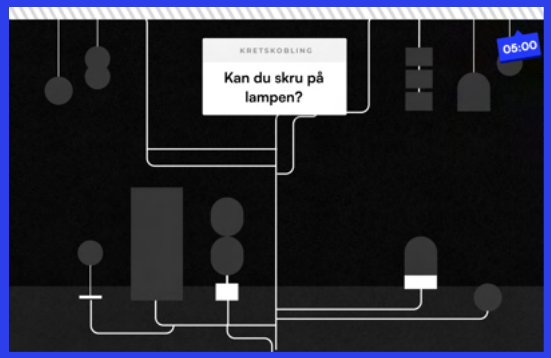

REFLEKSJONER
Hvordan kan strålen treffe øyet?
Katrine
Thorsen
Markus
Kasja
Amanda
Linda
Rasmus
Line
Karoline
Mateusz
Permille
Amanda
Vadskin

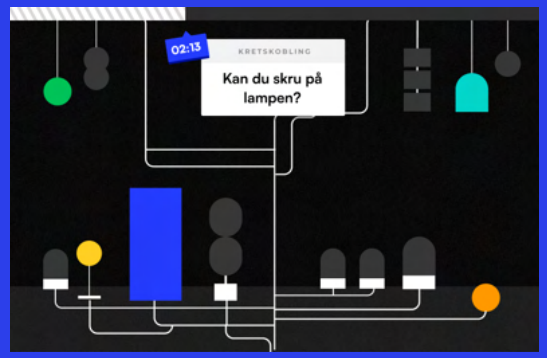
Circuit connection

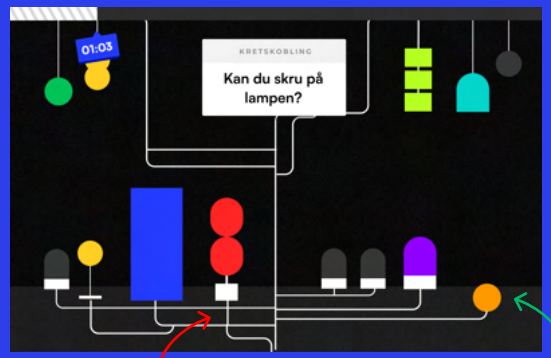
This activity is about understanding circuit connections. The example has each participant draw lines to connect a cable between the different components, that will then light up a specific lamp on the other screen.



Timer



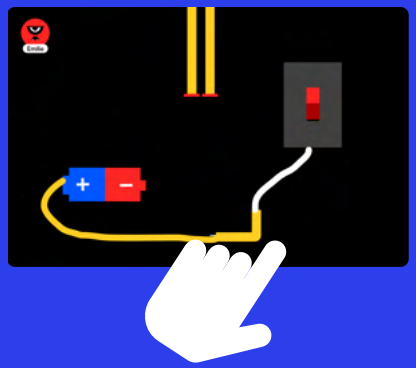




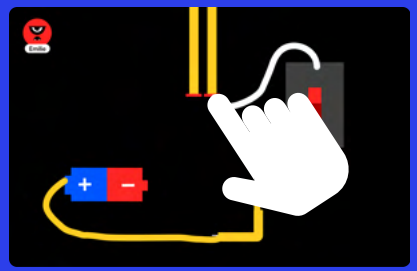
Your lamp

Other participant lamps

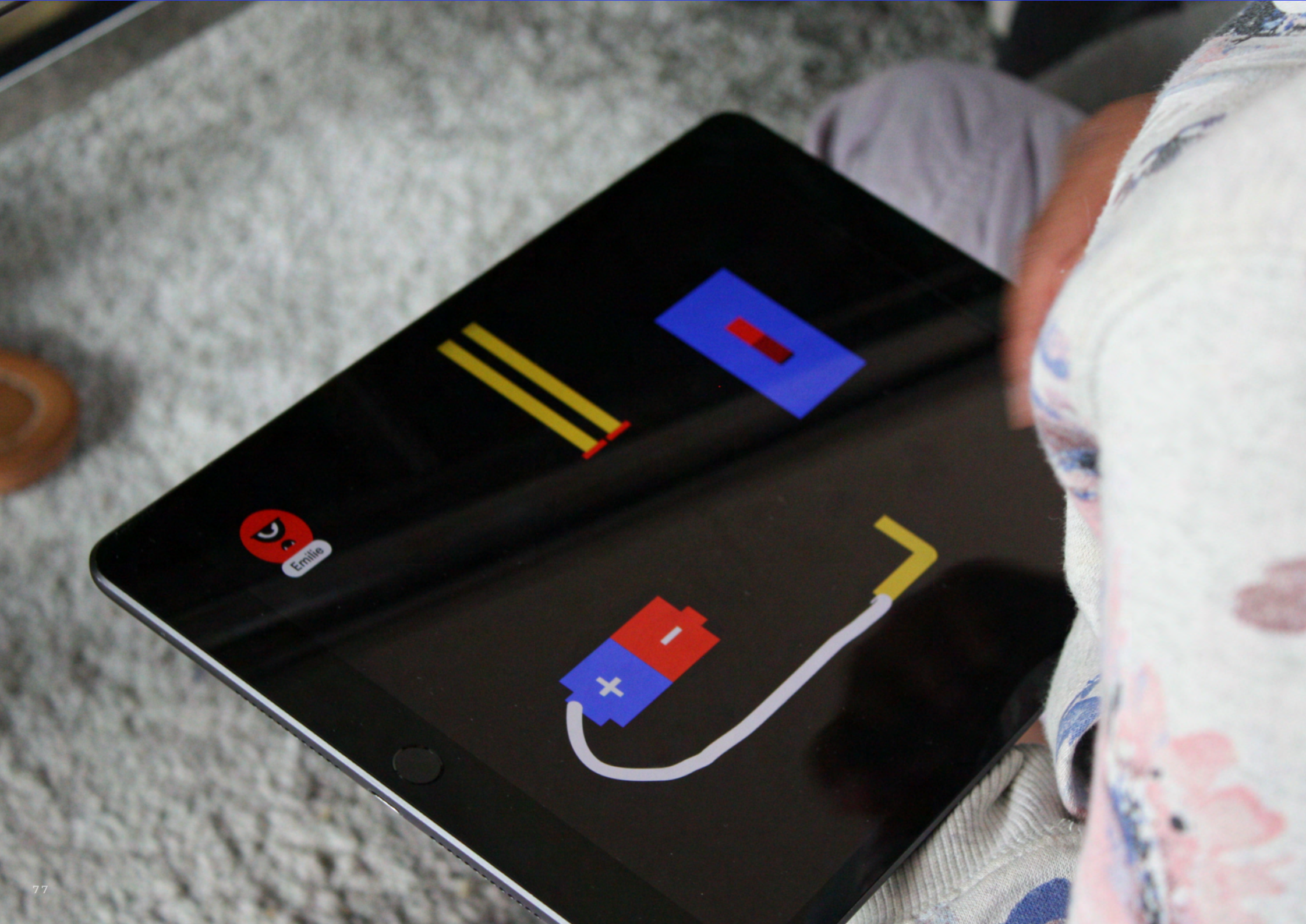
Start



Connecting



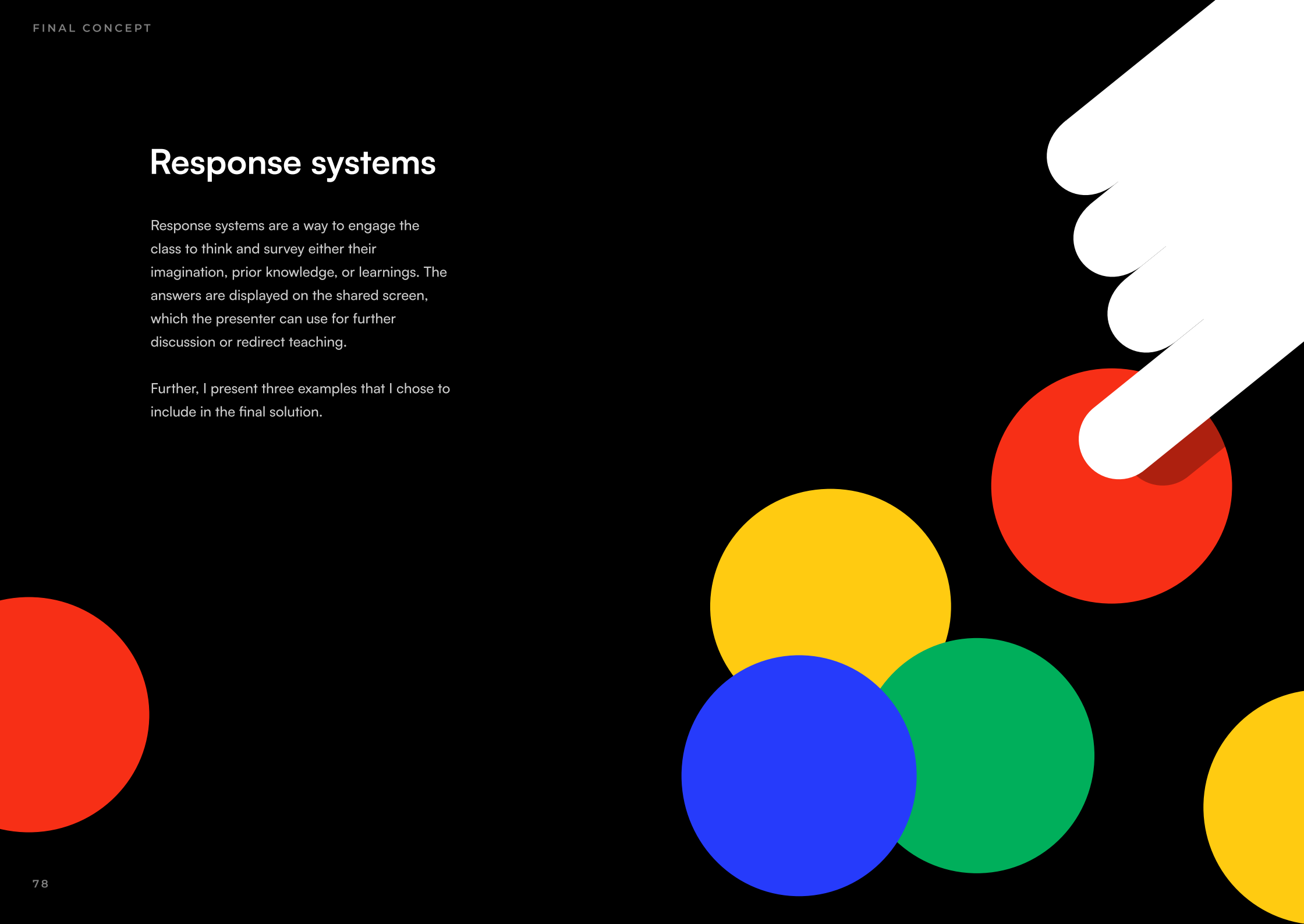
Completed


Emilie

Response systems

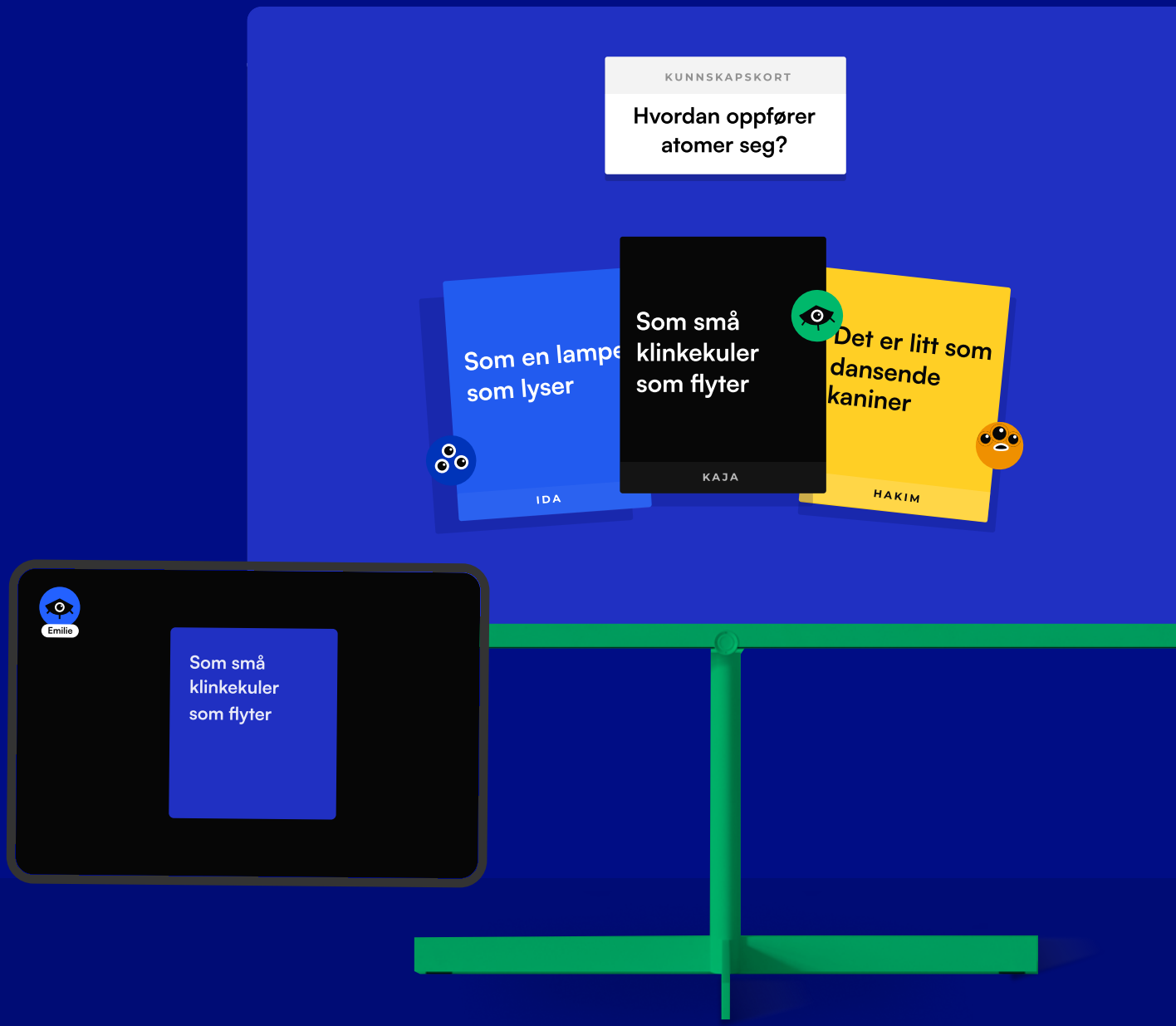
Response systems are a way to engage the class to think and survey either their imagination, prior knowledge, or learnings. The answers are displayed on the shared screen, which the presenter can use for further discussion or redirect teaching.

Further, I present three examples that I chose to include in the final solution.

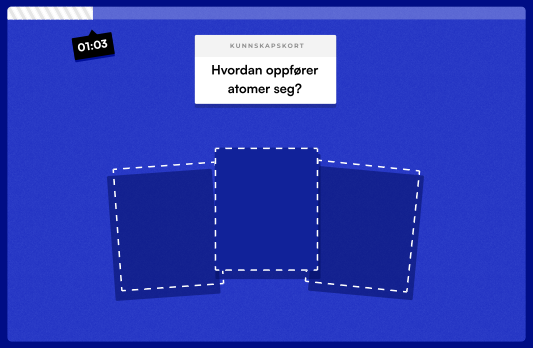


Question cards

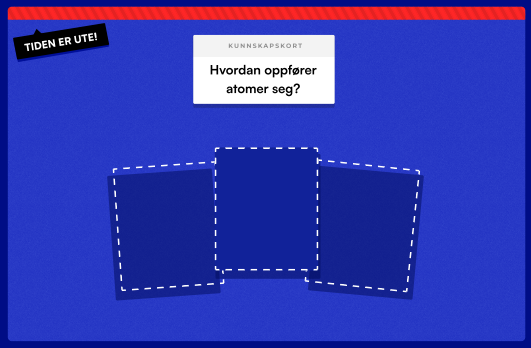
With question cards, participants are urged to reply to a question, with text. After the time limit is up, three answers can be displayed on the secondary screen. The teacher can use the answers to leverage a discussion, or redraw a new set of cards.



Question



Time's up



Card draw

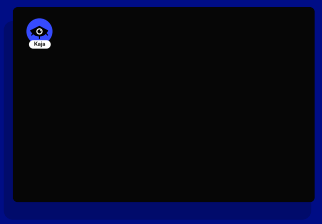
Start

Input

Locked

Not drawn

Drawn

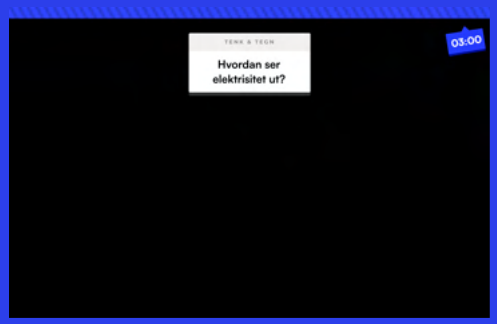


Draw together

In “Draw together”, a question is presented with the option to draw on a shared board. Each participant is initially positioned within a part of the screen, but by using two fingers, they can pan around. Presented with a question, like “what does electricity look like?” the board offers the option for numerous interpretations.

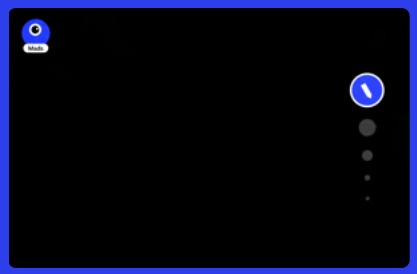
This example also encourages participants to build and add to each others drawings.

Start + question



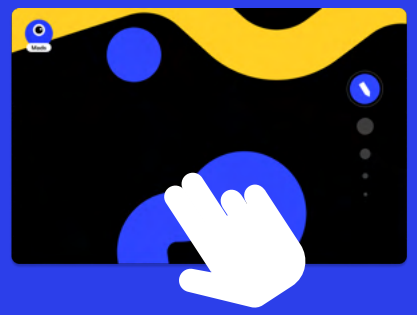
Participant drawings start appearing

Participants add to eachothers drawings



Question

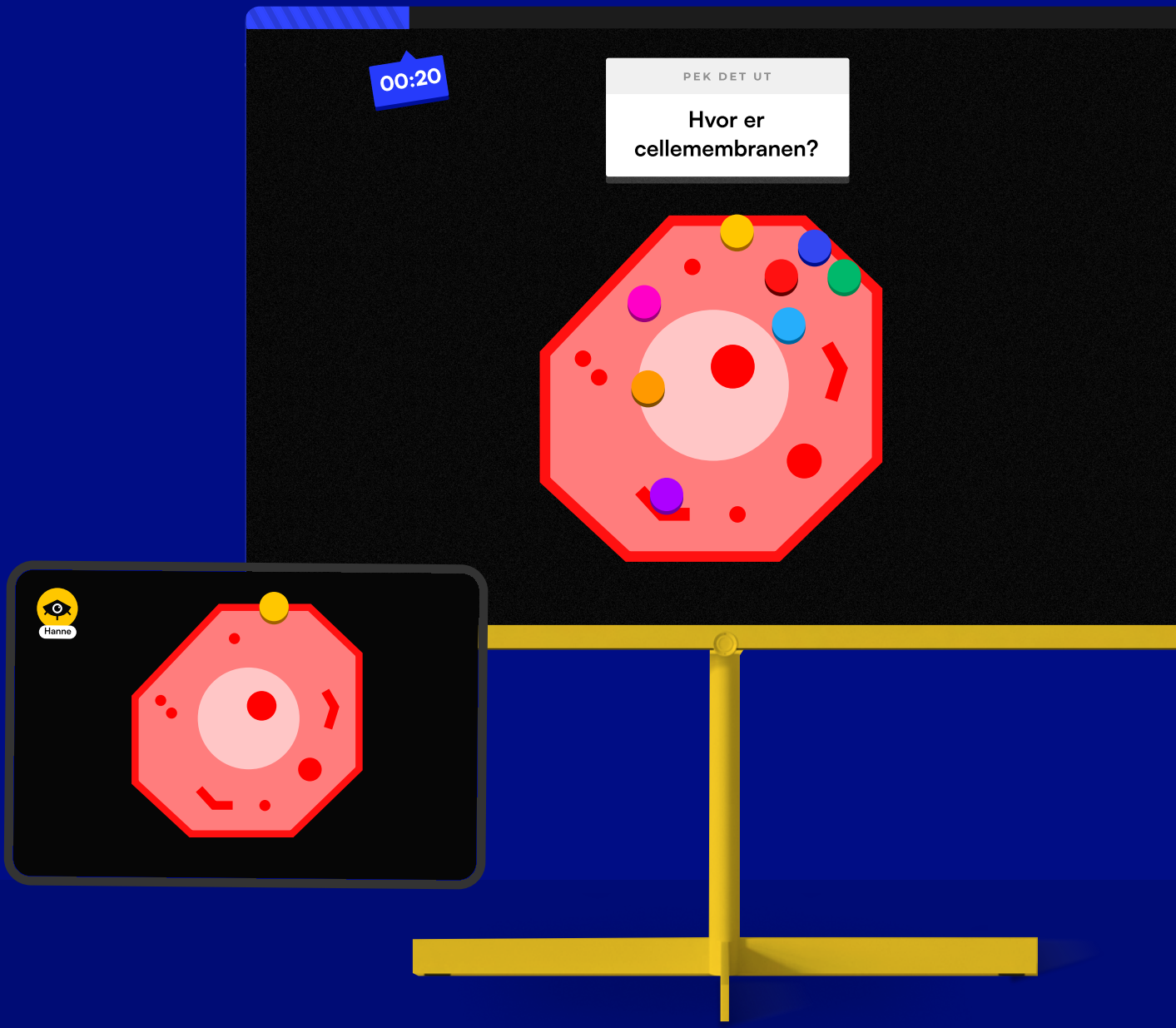
Draw



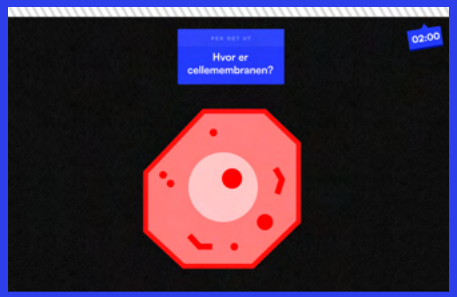
Pan

Point it out

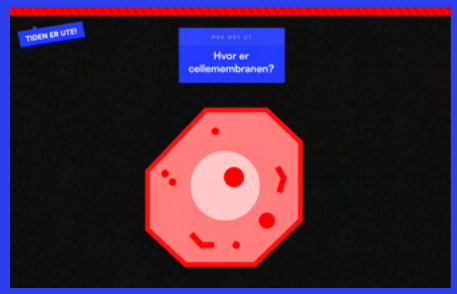
“Point it out” offers the opportunity to reply with taps. The replies in this example, are displayed in a heatmap-like manner on the secondary screen.



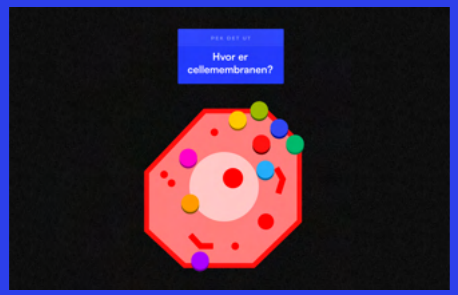
Point it out

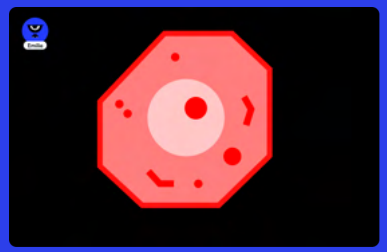


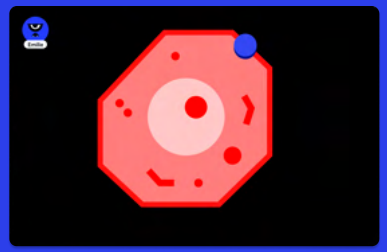
Time's up

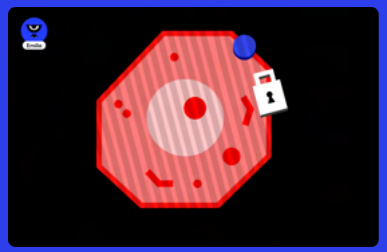


Heatmap





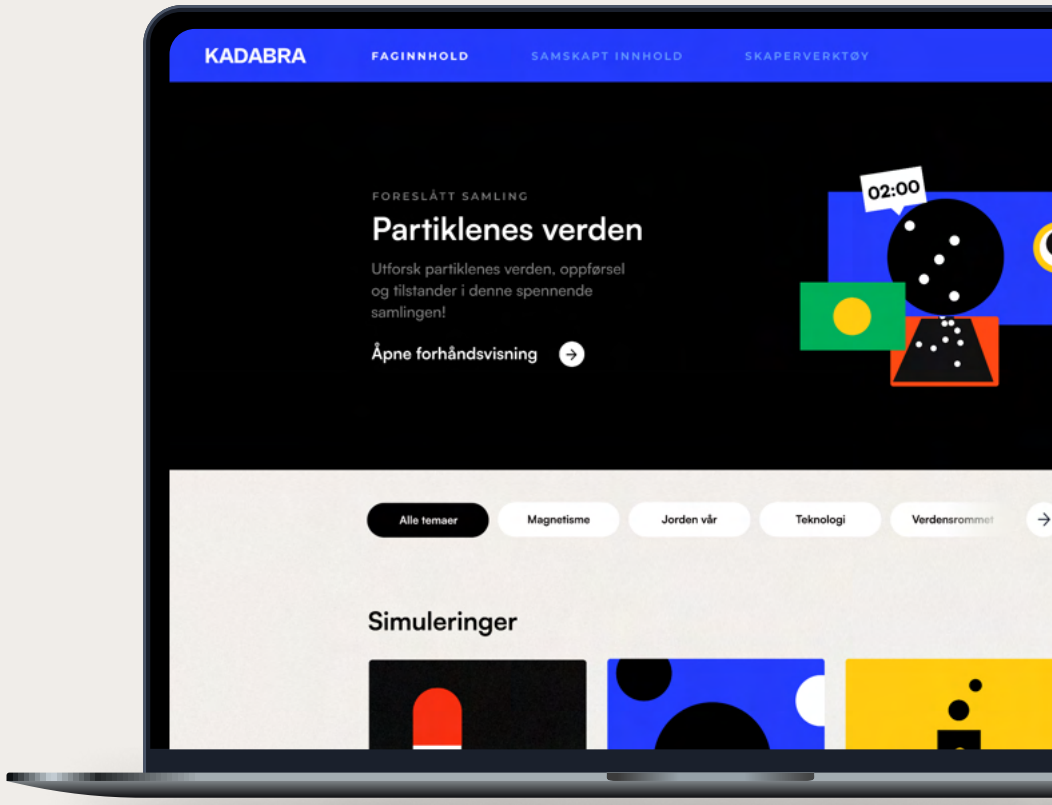




Kadabra as a library

The main navigational page is the content library. This page features produced simulations, the response activities, as well as stacks.

By creating a user, anyone can browse through the content, or launch activities and stacks. These can also be saved for later use in a personal page.

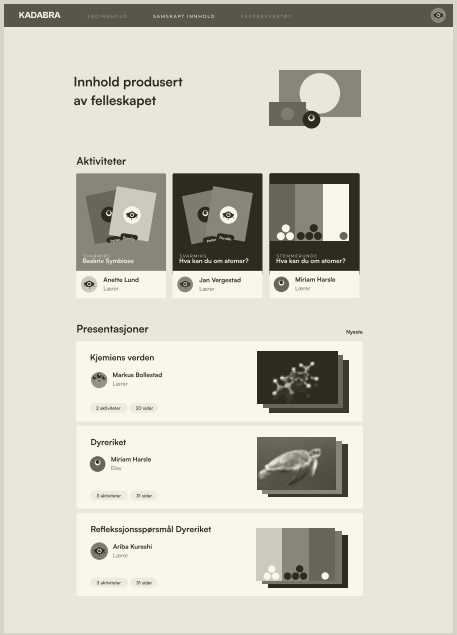


Main flow

Suggested pages

Editing tools

Community library



Page navigation

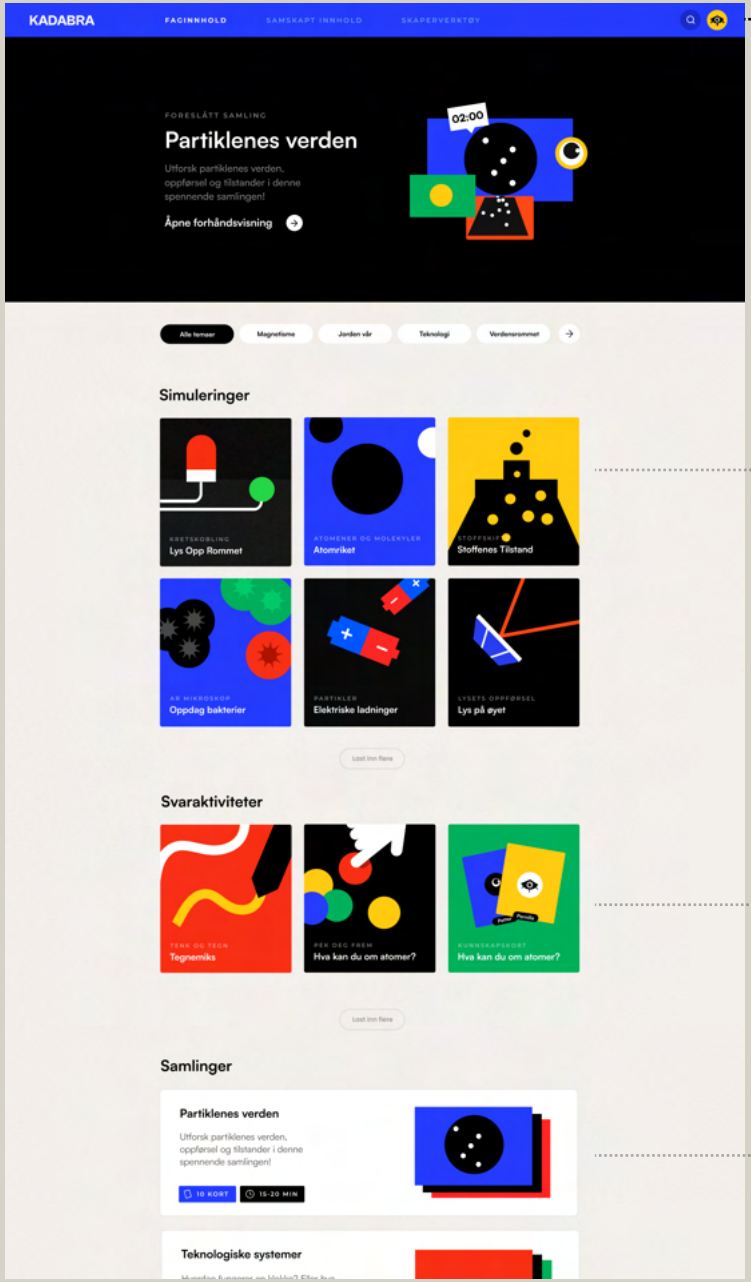
Suggested content

Topic navigation

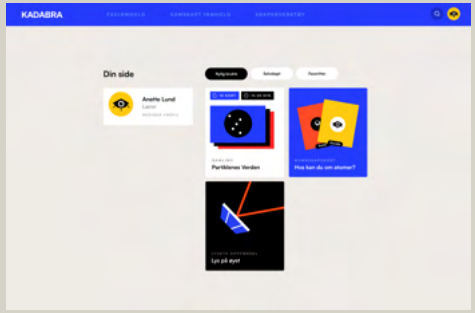
Simulations

Activities

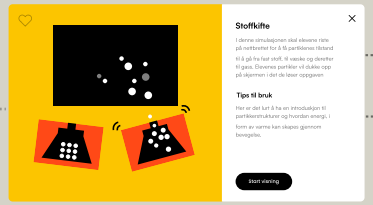
Stacks



User page

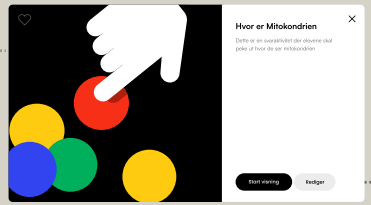


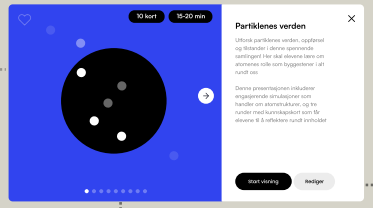
Activity/stack information



Introduction

Tips for use



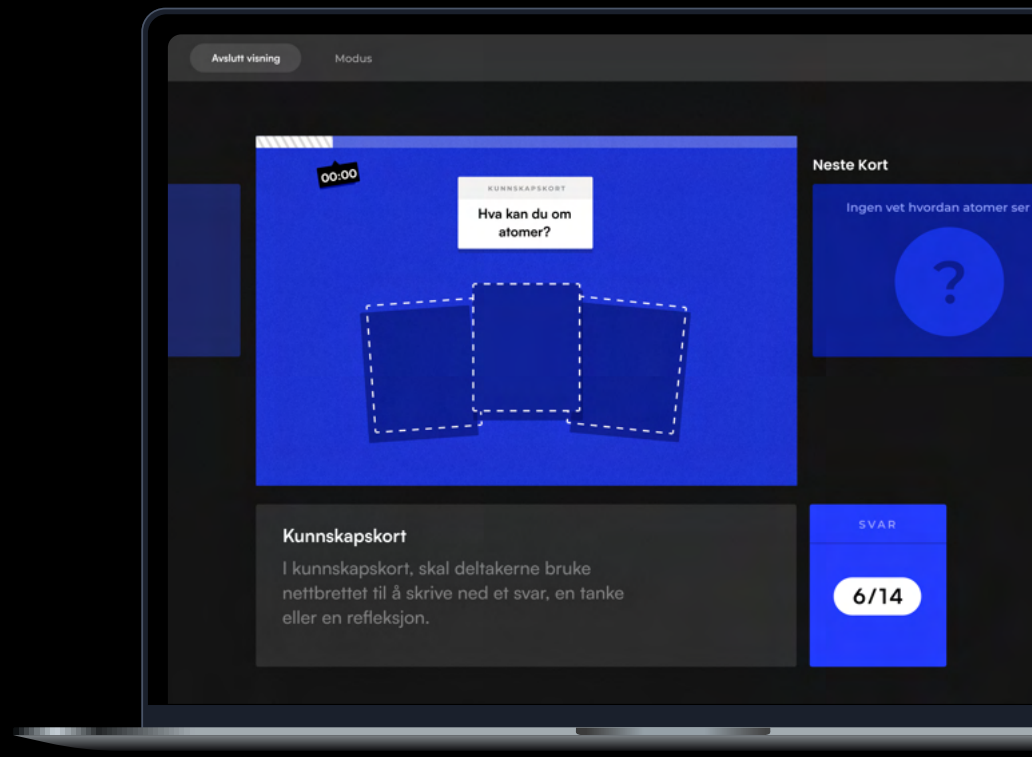


Edit

Cards preview

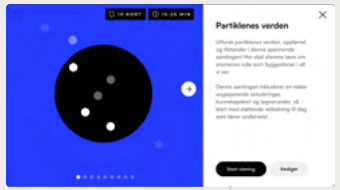
Presenter display

Kadabra, provides the option to have additional control when conducting a multi-screen lecture. The presenter display offers the option of additional notes, controls and a better overview.

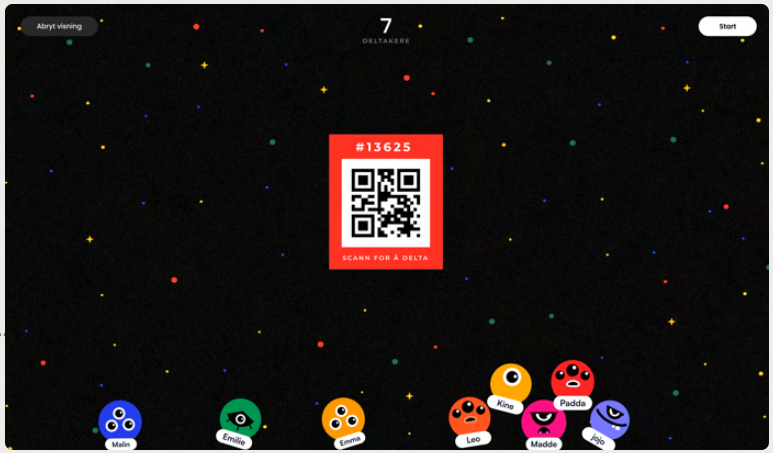


Entering flow

Stack

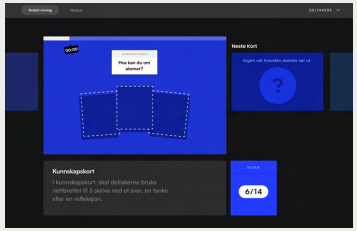


Lobby



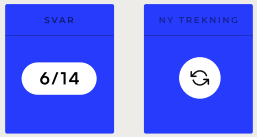
Projector/secondary screen

Control screen



Additional tools

E.g. redraw question cards, or answer amount



Support notes

For activities

Support notes

For regular cards

Personal notes

For user edited/built stacks

Design elements

Branding

The branding unifies the products visuals and interface. The style features a bold color palette that conveys a resemblence to outer space, while using symmetry, and simple geometric shapes.

Logo

KADABRA

Illustration style

Colors

000000 FFFFFF FB2626 2036FF F6C138 008F53

Fonts

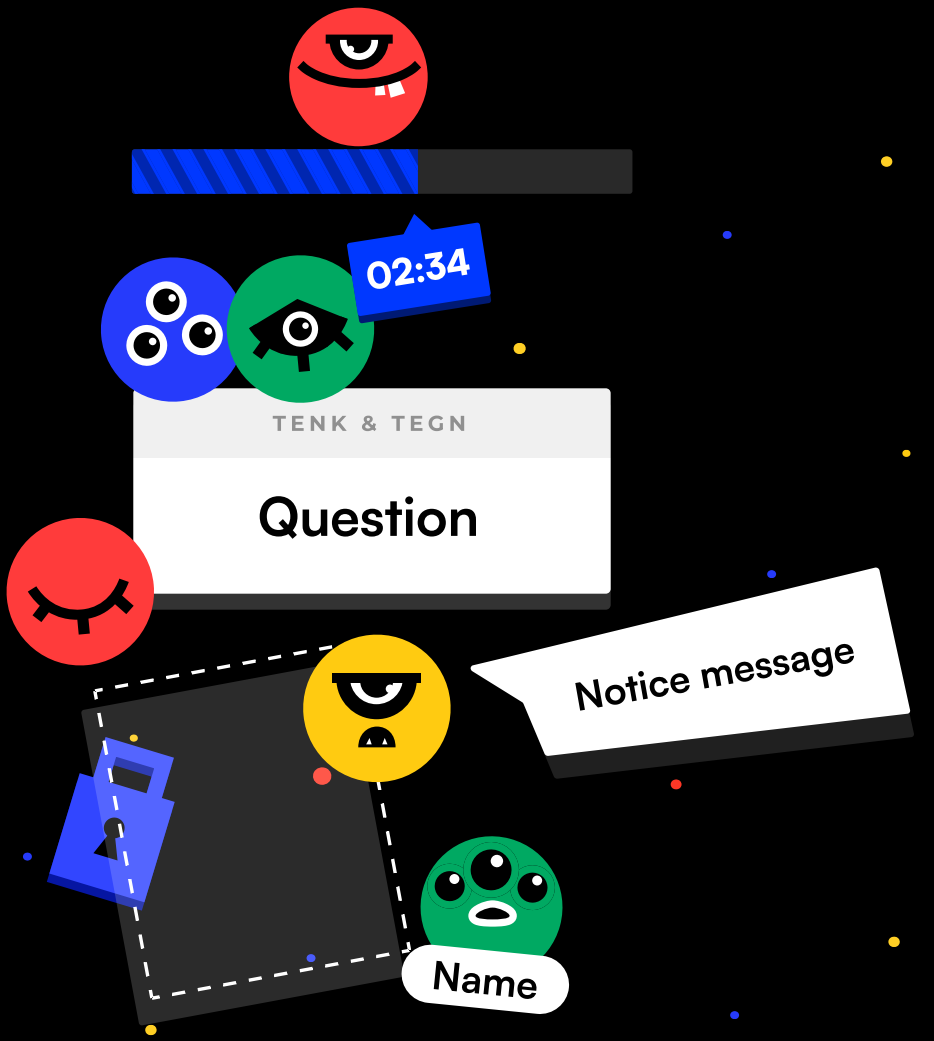
Satoshi Bold

Satoshi medium

MONTSERRAT

Activity components

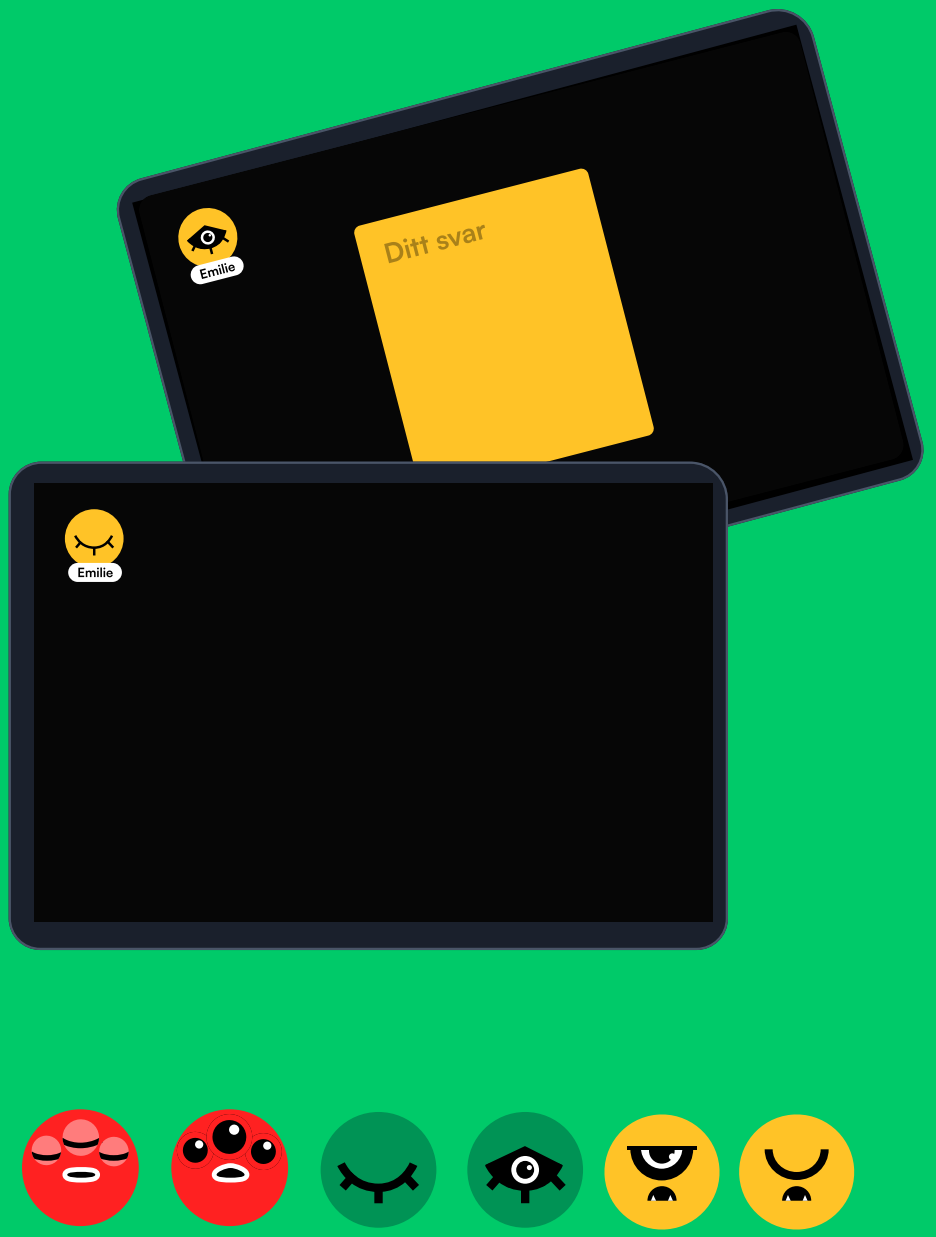
Kadabra also features a simple and reusable design system, that can be seen reocurring in the different activities.



Attention states

When participating in the sequence of a stack, the participant tablet alternates between the active mode, and a inactive mode.

The first directs focus to the activity, while the other indicates that while still connected, the focus should be on the secondary screen, paying attention to the monologue.

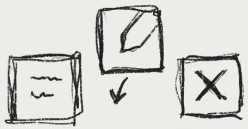


Scenario

Tom is a natural science teacher, who recently discovered Kadabra while trying to find new ways of engaging his class in the science topic

Tom opens Kadabra, and browses through in the the content under the topic of substances.

He stumbles upon a relevant stack and clicks through the previewed contents and tips.



He notices that some of the formulations are too difficult for the level of his class. He decides to modify the stack to his preferences and adds a few additional introductory response activities.

Tom saves the edited stack to his library, and the next day, he launches it with his pupils.

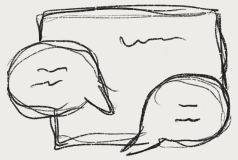
The class pull out their tablets, and scan the QR code. Upon entering they pick a name and a character face.

Once everyone has entered, Tom launches the sequence.

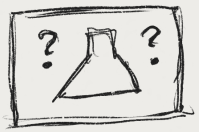
Tom introduces the topic by asking the pupils to draw their assosiations of a substance, through the response activity “Think & Draw”.

The class begins drawing a number of various interpretations.

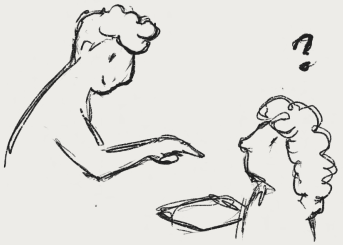
Tom talks them through the activity and leverages a few drawings for further discussion and questions.



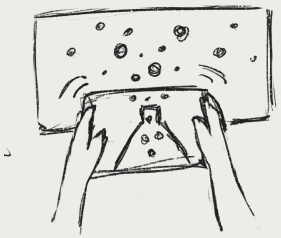
Tom proceeds with the lecture, and continues by explaining the topic of substances, using the cards in the stack.



After a bit of monologue, he introduces the next activity: Substance shift.

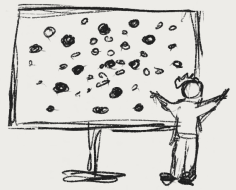


The class is a bit confused at first, but Tom guides them through the activity.



Based on the previous monologue, a pupil remembers that heat can be generated through movement. As he starts shaking the tablet, particles begin appearing on the second screen.

Others notice what’s happening, and start doing the same thing.



Soon the screen becomes littered with particles. Solids have transitioned over to gas. Tom gains the attention of his class, and begins explaining what they just achieved.

Modularity

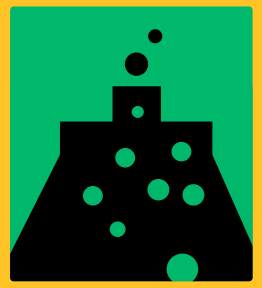
An important finding during the research was that no teacher, lesson plan, or structure is one and the same. For this reason, it became important to develop Kadabra as a modular solution with different entry points to choose from. The library offers entry points on several different levels. Through stacks, teachers can take advantage of a pre-produced path, or a self-created one through the editing tools. Individual activities, can also be incorporated at any point during a lesson.

Traditional stack

Using a pre-produced traditional stack, with informational context and a progression system

Creating your own

Creating stacks, editing response systems, or a combination to form unique lessons.

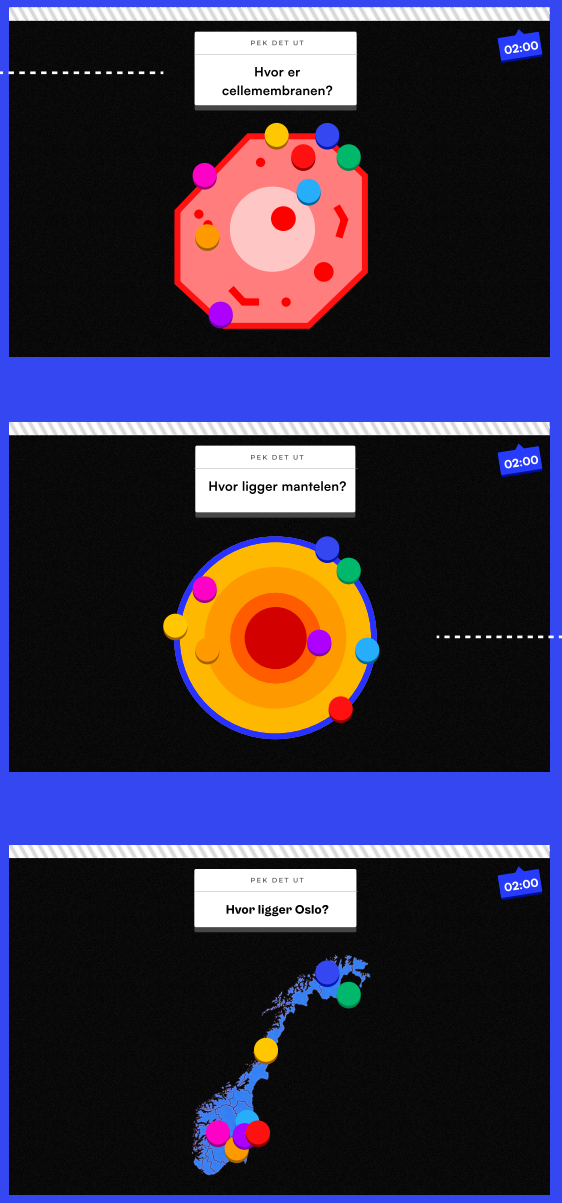


Stand-alone

Use an individual simulation or response system, to supplement to other ways of teaching.

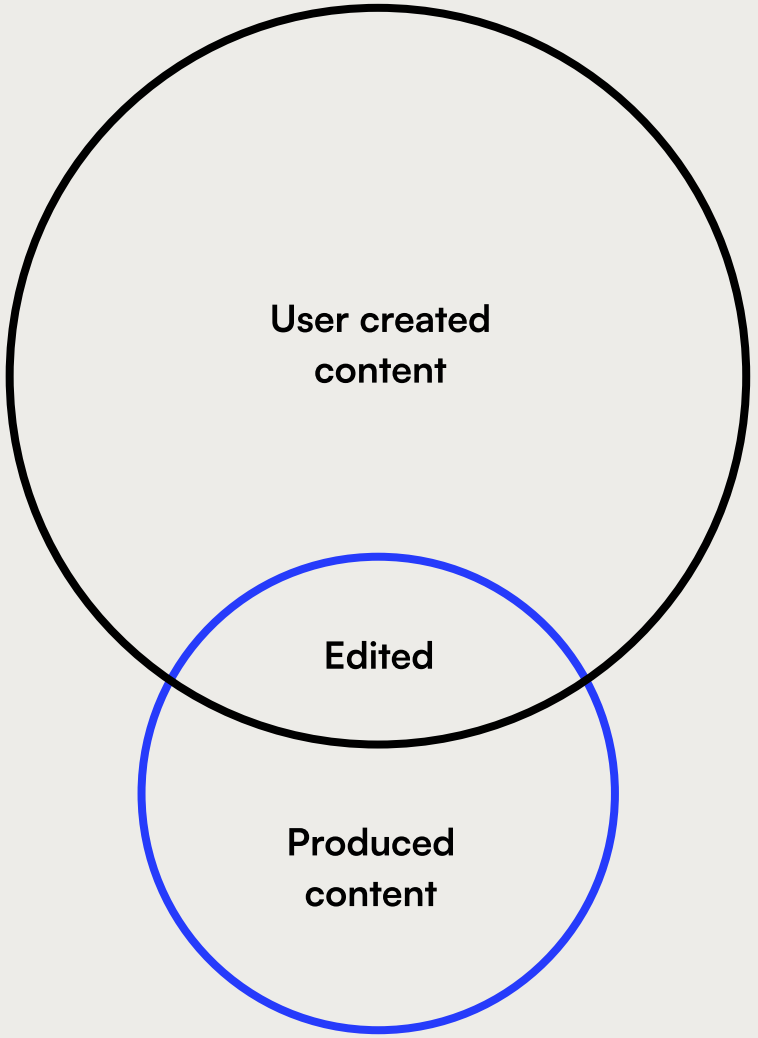
Editing options

The solution takes into account the possibilities for editing features. The editing possibilities can be seen within the openness of the response systems. Their aim, is for anyone to be able to change the question or the motive.

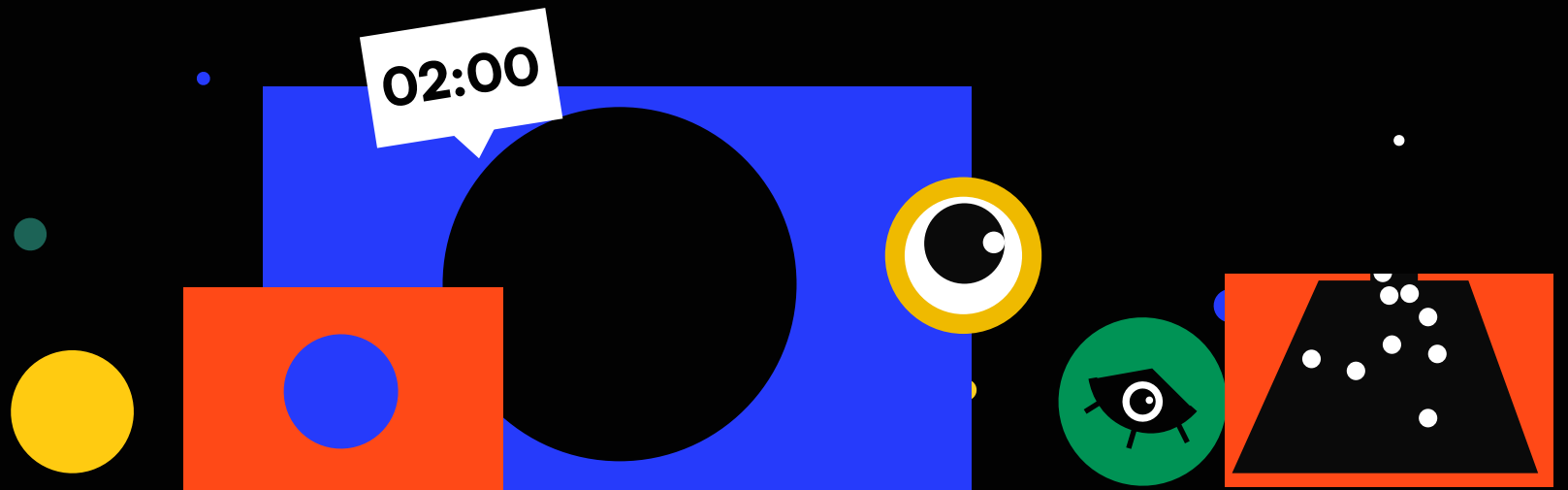


Scale potential

Editing capabilities opens up for a large library of additional content. Over time Kadabra has the potential to expand as a solution with a combination of produced, and user created content.



KADABRA



07.

REFLECTIONS

Evaluation from experts

Tore stavlund

Project manager for digital development projects in Aschehoug

Tore said that it was a fun solution that appears to fit really well in its context, and is easy to imagine in a classroom setting. He found that a response system could create a wide and rich variety of content, based on one variant alone.

He believed that Kadabra, as a service and a product, could influence many science teachers. He found that it could positively affect the interactivity between student and teacher, and with a good response system for the dynamics in the classroom.

He mentioned the factor of having enough variety of content. The willingness to purchase will largely depend on the relevant content available, and how it fits in relation to the rest of the academic material. Instead of revolutionizing, it hangs in line with the new possibilities digital devices have provided and supports the recent transformation.

Peder Schou

Head of the digital department in Gyldendal

Peder found that the idea appeared realistic, rich, and easy to imagine the use of it. He said that the fact that there are two modes, ties the idea together well and that there are several entry points to choose from.

He sees that it fits the school setting well and could launch a challenger in the market. It takes into account the broad perspective, instead of the raw thinking it should immediately reach everyone. He found that the project takes on how the world actually is without speculating or getting hung up on small technical details.

A potential challenge he sees exists in the scalability of the simulations, and they would need some common components to work with the demanding fact of content production. However, the response systems seemed largely scaleable and easy to recognize being used.

Reflections

Concept

The strength of the final concept lies in the physical presence and the shared social experience. At the same time, it takes into account how we actually learn, and how a teacher operates. Instead of looking down at the screen and isolating an individual activity, it lifts the eyes and demands participation and presence. I would enjoy seeing the solution come to life in a classroom setting. Seeing its effects on social dynamics, motivation, and curiosity.

For Kadabra to provide its intended value, a library of content would need to be developed. While the opportunities within the screen are vast and complex, they also require an equal amount of effort to produce. I imagine Kadabra as a collaboration between designers and educationalists working together to build a library of content, along with a user-supported community.

I also see Kadabra as working in harmony with other existing content on the market, working primarily as an introductory tool to science topics.

However, to reach the end of the road, Kadabra still faces trials in its true environment - the classroom. Within both the time frame and technological complexities of the solution I was limited with the scale of my testing. It would need testing both with five participants, as well as forty.

If I had more time, I would have explored even more solutions when it comes to the use of multiple cooperating screens. I think the research and explorations opened up for a broad range of possibilities, and It would be interesting to also look into concepts surrounding group work, work over longer periods of time, or within more subjects.

In the end, I am aware that Kadabra is another product in a vast and highly saturated market. However, I also see Kadabra creating value in the form of inspiration through its explorative approach.

Personal growth

This project affected my growth as a designer in several aspects. Through many ideation loops and ideas that missed the mark, it challenged me to move forward and try again. The topic pushed me to explore more drag me out of my comfort zone, challenge my assumptions, and most of all, leave doubt behind and trust the approach. I also learned a lot about technology, and people, which I see as valuable learnings for me as a designer in the future.

Final thoughts

This project explored possibilities within the use of screens in a social learning context. Here the participants are the main communicators. The tasks and activities, live within the solution, but they cannot work solely on their own, as at least not in any near future, will digital tools be able to surpass every physical learning experience.

In this project, I found that digital devices offer many possibilities, both when it comes to learning, and social benefits. Taking advantage of digital opportunities does not have to equal an extensive amount of resources or risk. Considering the context, space as well as people using it, are equally important in designing useful solutions. In the end, this project inspired me to think more about how we can create meaningful digital products in a more human way.

Special thanks

A very big thank you to all the people that were a part of this process.

Mosse sjaastad - For the continued support, effort, and encouragement

Peder Skou - For his invaluable feedback, additional resources and aid

Theo Tveterås - For reviewing early concepts and for sharing his expertise

Jannicke Ekenes Asp - For great input and sharing her knowledge

Tore Stavlund - For sharing industry knowledge, contacts and reviewing my concepts

Fellow students - For the aid, and for making this process a bit more cheerful

Lars Marcus Vedeler - For early guidance in the process, and much needed resources

There were a number of anonymous helpers throughout my project. Their input and aid was equally valuable. Thank you so much.

Sources

Citations

C.Alexander(2016) Is something missing from E-learning?, Chris Alexander, Elearning Industry https://elearningindustry.com/something-missing-from-e-learning

M.Heie(2021),Digitalisering i skolen: Hva viser forskning så langt?,Magnus Heie https://forskning.no/barn-og-ungdom-informasjonsteknologi-partner/digitalisering-i-skolen-hva-viser-forskning-sa-langt/1812062

A.Halme(2021), What is Bret Victor Trying To Do?,Antti Halme https://notes.fringeling.com/WhatIsBretVictorTryingToDo/

S. Spurkland, M. Blikstad Balas(2016),Digitalisering av skolen: De største utfordringene. https://utdanningsforskning.no/artikler/2016/digitalisering-av-skolen-de-storste-utfordringene/

C.Geison(2019), what in the ux is “wizard of oz testing”?, Chris geison, https://www.answerlab.com/insights/wizard-of-oz-testing#:~:text=Wizard%20of%20Oz%20(WoZ)%20is,operator%20in%20the%20next%20room

Utdanningsdirektoratet, 2020 Fagfornyelsen https://www.udir.no/laring-og-trivsel/lareplanverket/fagfornyelsen/
https://mspguide.org/2022/03/18/problem-tree/

Sources

R.Bjork(2015), How to use cognitive psychology to enhance learning, Robert Bjork, Google podcasts https://podcasts.google.com/feed/aHR0cHM6Ly9mZWVkcy5wb2RjYXN0bWlycm9yLmNvbS90ZWFjaGluZy1pbi1oaWdoZXItZWQ/episode/aHR0cHM6Ly90ZWFjaGluZ2luaGlnaGVyZWQuY29tLz9wPTIyNjA?hl=en-NO&ved=2ahUKEwjkzPzZxer3AhVlR_EDHf_RBbMQjrkEegQIBRAF&ep=6

Sources
A.Furberg, J.Dolonen, L.Ingulfsen(2015)Anniken Furberg, Jan Arild Dolonen & Line Ingulfsen, Universitetet i Oslo https://www.uv.uio.no/iped/forskning/prosjekter/ark-app/publikasjoner/downloads/rapport-12-nat-5-kl.pdf

J.Bower, C.Christensen(2022) Disruptive Technologies: Catching the Wave, Joseph L.Bower, Clayton Christensen, Harward business review https://hbr.org/1995/01/disruptive-technologies-catching-the-wave

B.Victor(2011), The ladder of abstraction, Bret Victor, Worrydream http://worrydream.com/#!2/LadderOfAbstraction

C.Wieman(2014), Stop Lecturing Me, Carl Wieman, Scientific American https://www.scientificamerican.com/article/stop-lecturing-me/

D.Pink(2009), The puzzle of motivation, Daniel Pink, Ted https://www.ted.com/talks/dan_pink_the_puzzle_of_motivation

A.Furberg(2016), pp.16, Lærerrollen i teknologitette klasserom,Anniken Furberg, Universitetet i Oslo https://www.uv.uio.no/iped/forskning/prosjekter/ark-app/publikasjoner/downloads/rapport-12-nat-5-kl.pdf

R. Bjork(2009), Learning: Making Things Hard on Yourself, But in a Good Way: Creating Desirable Difficulties to Enhance Learning, Elizabeth L. Bjork and Robert Bjork, Bjorklab https://bjorklab.psych.ucla.edu/wp-content/uploads/sites/13/2016/04/EBjork_RBjork_2011.pdf

B.Victor(2013), Stop drawing dead fish, Vimeo, https://vimeo.com/64895205

Ø.Gilje(2016), Øystein Gilje, Line Ingulfsen, Jan A. Dolonen, Anniken Furberg, Ingvill Rasmussen, Anders Kluge, Erik Knain, Anders Mørch, Margrethe Naalsund og Kaja Granum Skarpaas, Med ARK&APP Bruk av læremidler og ressurser for læring på tvers av arbeidsformer, https://www.uv.uio.no/iped/forskning/prosjekter/ark-app/arkapp_syntese_endelig_til_trykk.pdf

Kunnskapsdepartementet(2017), Framtid fornyelse og digitalisering https://www.regjeringen.no/contentassets/dc02a65c18a7464db394766247e5f5fc/kd_framtid_fornyelse_digitalisering_nett.pdf

UUtilsynet(2017)Kartlegging av digital læremidler og læringsplattformer i utdanningssektoren, UUtilsynet https://www.uutilsynet.no/andre-rapportar/kartlegging-av-digital-laeremidler-og-laeringsplattformer-i-utdanningssektoren/943#31_markedsandeler_andel_skolereleve r

G.Torgersen(2018)Den norske befolkningen er blitt bedratt om digitale læremidler, Glenn-Egil Torgersen, Herner Sæverot https://www.aftenposten.no/meninger/kronikk/i/Qlqm9P/den-norske-befolkningen-er-blitt-bedratt-om-digitale-laeremidler-glenn-egil-torgersen-og-herner-saeverot

D.Albert(2022)Kahoot! Norway's Obsession with the Quiz App, Daniel Albert https://www.lifeinnorway.net/kahoot-quiz-app/

Images

Taylor Wilcox
https://unsplash.com/photos/4nKOEAQaTgA

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https://unsplash.com/photos/4nKOEAQaTgA

Freepik
https://www.freepik.com/free-photos-vectors/screen-presentation


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