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Master thesis
Tao Chen

Design for Interaction
TU Delft
March 2022



PROMOTIVATE:

Design for social dynamics to promote sustainable behavior in secondary schools

Master thesis

Design for Interaction

Tao Chen

March 2022

Delft University of Technology

Faculty of Industrial Design Engineering

Committee

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ENERGE

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PROMOTIVATE

Design for social dynamics to promote sustainable
behavior in secondary schools

Appendix 1

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 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
initials
student number
street & no.
zipcode & city
country
phone
email



Your master programme (only select the options that apply to you):

IDE master(s): ☐ IPD ☒ Dfl ☐ SPD

2nd non-IDE master: _____

individual programme: _____ (give date of approval)

honours programme: ☐ _____

specialisation / annotation: ☐ _____

☐ _____

☐ _____

SUPERVISORY TEAM **

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

** chair _____ dept. / section: _____

** mentor _____ dept. / section: _____

2nd mentor _____

organisation: _____

city: _____ country: _____

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.



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

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair _____ date _____ signature Stella d'A.

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: 33 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 30 EC

List of electives obtained before the third semester without approval of the BoE

☒ YES all 1st year master courses passed

☐ NO missing 1st year master courses are:

name C. van der Bunt date 15 - 11 - 2021 signature CB

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)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- 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 ?

Content: ☒ APPROVED ☐ NOT APPROVED

Procedure: ☒ APPROVED ☐ NOT APPROVED

comments

name Monique von Morgen date 23/11/2021 signature _____

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 - - - - end date

space available for images / figures on next page

introduction (continued): space for images

image / figure 1:

image / figure 2:

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.

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.

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.

start date - - - - end date

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.

FINAL COMMENTS

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

Appendix 2

Other user research insights

Focused code 1: Low effective communication's negative effects on pursuing sustainability and comfort

Low effective communication between stakeholders causes negative effects towards sustainability and comfort.

The janitor who controls the heating doesn't communicate with teachers, which causes energy waste and discomfort. Teachers sometimes don't like students' action when students try to seek comfort but break social rules. School directors usually can't make an agreement with the student council on the school plans for sustainability.

Initial code 1: Better communication can help saving energy

Better communication between stakeholders like the janitor and teachers about heating can improve the energy conservation.

Student council can help to communicate ideas with teachers to save energy.

Initial code 2: School director often disagrees with student council

School director usually disagrees with sustainability plans from student council due to their low feasibility regarding cost and effort, although the director likes the plans, which makes students think that the director pretends to care about sustainability.

Initial code 3: Teachers don't like some students' behaviors

Teachers don't like some students' behaviors in the class when students break social rules in the class, which affects effectiveness of actions upon discomfort.

Focused code 2: Understandable and actionable indications are wanted

The indoor climate can be measured and indicated, and hints can be provided to take actions. People want to have such interactions with indoor climate data especially during class in the classroom. So they can manage comfort efficiently with less disagreements.

Initial code 1: Indoor climate sensor indicates air quality in an easy way

The sensor should tell people how the air quality is and gives people hints of how to take actions for their comfort and also back them up. People should be able to glance and understand the indoor climate indication easily.

Initial code 1: Students' ideas of using energy efficiently

Students have ideas and mindset of using energy in an efficient way and saving energy when not using it. From homework and exercise, students show what they can do to improve usage of energy. And they have the idea that it's handy and energy-efficient to digitalize energy use in every room and the janitor or teachers can have access to.

Initial code 2: Cope with the effect of regulation change in pandemic

During the pandemic, windows has to be open and it becomes quite cold in winter. So radiators are turned up as high as possible and coats and blankets are allowed in the classroom.

Other visualization design strategies

1. Provide clear and useful information or feedback

This is a common approach that provides contextual and real-time feedback on consumption or in depth feedback allowing users to explore consumption patterns. If transfer it to indicating indoor climate data, real-time feedback on indoor climate and its quality can be indicated. From the user research, an insight about information visualization and communication is that during the class when they don't have spare time interacting with intervention, they want understandable and actionable indications from the intervention to support them manage their energy use and comfort. So this adapted strategy can be used when designing for the scenario of during the class.

2. Make consumption visible

This strategy is about exploring and cultivating sustainable lifestyles and values as well as raising public awareness and facilitating discussion and reflection. It can be a part of the school education in the form of irregular events for instance. The effect of it will show gradually in a long period of time. In my design, it worths trying only when a good idea appears, but can be further investigated by the ENERGE team.

3. Strategies for designing visualizations of different scale energy consumption

There is another strategy for designing visualizations of different scale energy consumption. Use visualization of large scale energy consumption e.g. a whole school building to raise awareness and motivate behavioural change, while use visualization of small scale energy consumption that inform changes of behaviour on the small level e.g. classrooms (Pierce et al., 2008). Hence, it's possible to bridge small efforts to sustainability changes in a school level.

Appendix 3

Design Cycle 1: Concepts

Pledge

<Desired interaction>

I want the users to interact with it as individuals and express their feelings of indoor climate during breaks or lunch time. They can be motivated to record their perceived temperature or air quality they experienced in certain time and place especially when they have complains. And they can speak their needs for thermal comfort.

Teachers or other stakeholders can view students' perceptions of indoor climate and detected indoor climate by sensors. Then react on the feedback.

I want the users to believe that they can do something in sustainability for the school as individuals. If they find any energy wasting issues e.g. waste of lighting or electrical machine, they can stop them and report them on the interface when it's in breaks or lunch time. These actions and their impact will be recorded for later rewarding. Besides, in order to motivate users, they will set goals of saving a certain amount of energy or number of actions they take at the beginning of the year. If they achieve the goal, they will get rewards.

<Feedback>

1. the function of reporting thermal comfort should be in the class
2. when does teacher see the students' feelings? Maybe at the start of the class
3. social goals of a class might be better than individual goals as students can think from a collective lens.
4. people won't report actions afterward. better to take actions
5. be smarter to show timetable and choose class instead. people don't remember much.
6. the interface is not easy to understand.

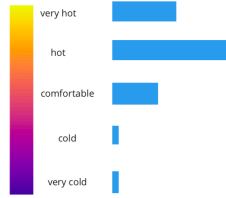
The mockup shows a user profile for 'PETER' with an avatar of a person with orange hair and glasses. The interface is divided into four sections:

- How do you feel the temperature?**: A vertical color gradient bar ranging from 'very hot' (yellow) at the top to 'very cold' (purple) at the bottom, with intermediate labels for 'hot', 'comfortable', and 'cold'.
- Choose the place**: A grid of buttons for 'Floor 1', 'Floor 2', and 'Floor 3'. Under 'Floor 1' are 'Classroom 1' and 'Classroom 3'. Under 'Floor 2' are 'Classroom 2' and 'Classroom 4'.
- How do you feel the air quality?**: A 2x2 grid of buttons labeled 'fresh', 'stuffy', 'smelly', and 'others'.
- Choose the time**: A horizontal timeline from 8 to 18 with tick marks and a white dot indicating the selected time, currently positioned at 11.

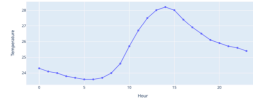


TEACHER

Students' feelings about temperature



detected temperature



Advice:
lower the temperature

PETER



Choose the place

Floor 1

Floor 2

Floor 3

Classroom 1

Classroom 2

Classroom 3

Classroom 4

wasting energy source

lighting

electrical device

Choose the time



energy saving goal of the year



Reward:
5 credits for the year

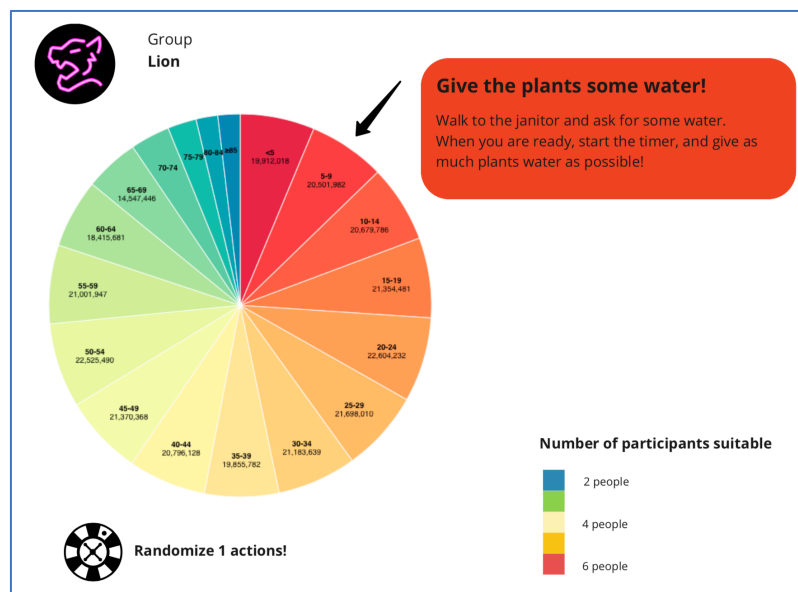
Action wheel

<Desired interaction>

I want the users to interact with it as groups and be motivated to participate group activities that contribute to sustainability of schools and indoor climate. They can do these activities like watering plants in 10 mins while having fun with friends during breaks or lunch time. They can be self-confident to execute the activities with detailed instructions of how to do them and proud to see the impact they make on energy efficiency and number of activities they've done in a period of time. And It's possible to participate activities to work on better indoor climate for the school.

<Feedback>

1. combine it with game
2. timer adds challenge not motivation
- 3a. a better story to show impact
- 3b. show overview of total contribution
- 3c. add a 'learn more' to provide more info. about impact
4. forbid vicious competition to avoid causing discomfort on purpose





Group
Lion

Give the plants some water!

Walk to the janitor and ask for some water.
When you are ready, start the timer, and give as much plants water as possible!



10 mins

Start!



Impact:
Reduce CO2 concentration 50 ppm

Number of activities participated



Group
Lion

Turn off lights

Go to the first floor and turn off lights in
Classroom 103 and 104.



lighting



5 mins

Start!



Impact:
Save energy 10KWh

Number of activities participated



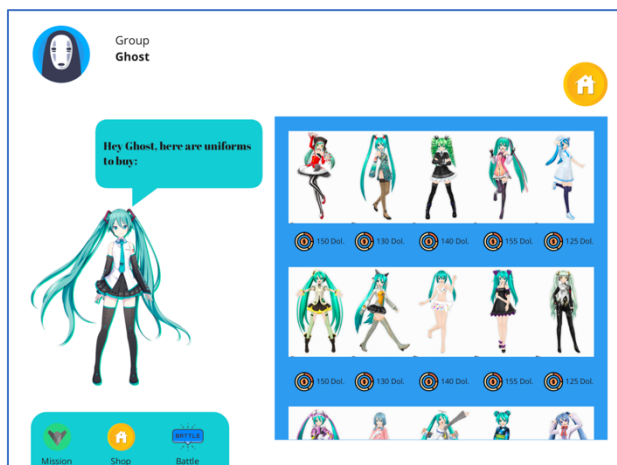
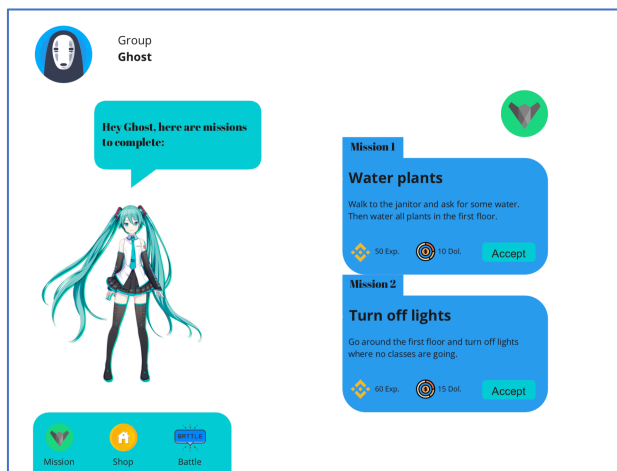
Character

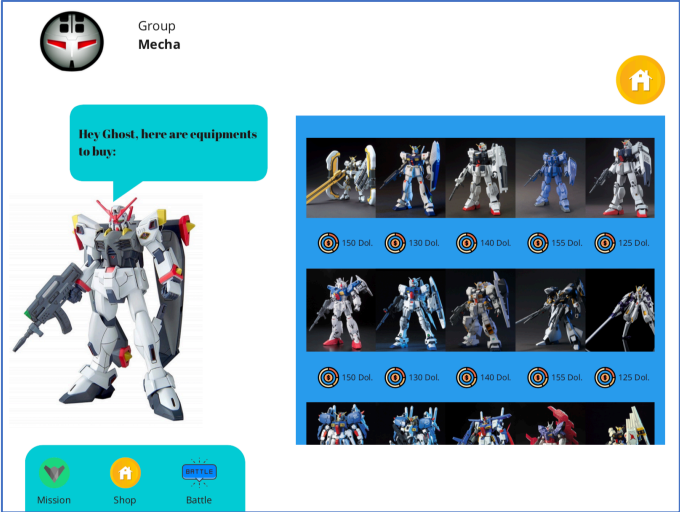
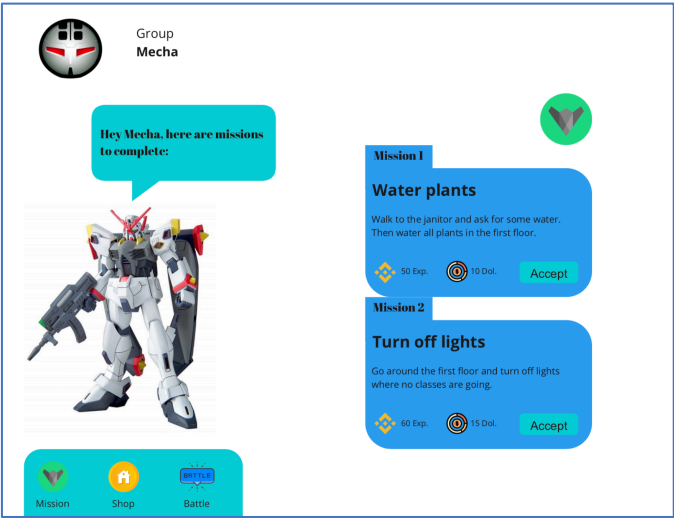
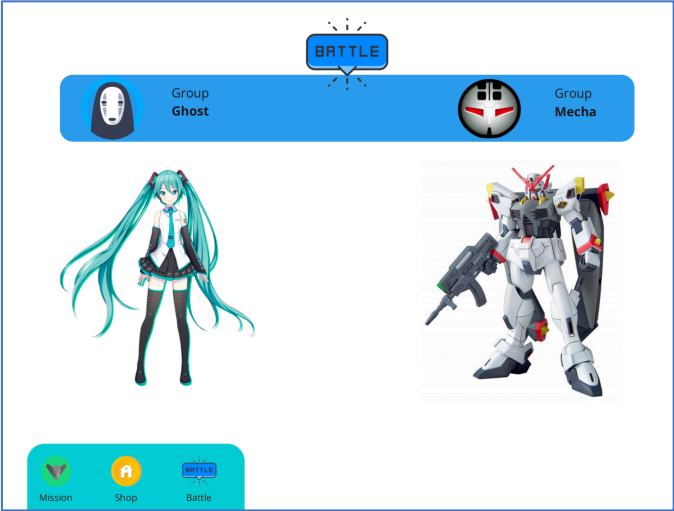
<Desired interaction>

I want the users to feel like interacting with a smart agent who can talk to you. It also feels like playing a game and the agent posts missions of solving energy related problems that are detected by sensors. Same as in games, users have a character to play and can gain experience point and 'money' after finishing missions, by which they can buy equipment to arm themselves and compete with other characters. Users would have motivation to work on sustainability while playing the game and interacting with characters. They can be self-confident to act on missions as detailed instructions of how to do them are provided.

<Feedback>

1. it's time consuming and too gamified. better to be neutral style
2. I like gamification. it gives people motivation to win in the game.
3. The tasks can be exclusively distributed to certain groups.
4. Show achievements and impact in a period of time apart from the game.
5. Add a ranking system to compare different groups
6. concrete actions give most confidence.
7. the game motivates people more than feeding pets.





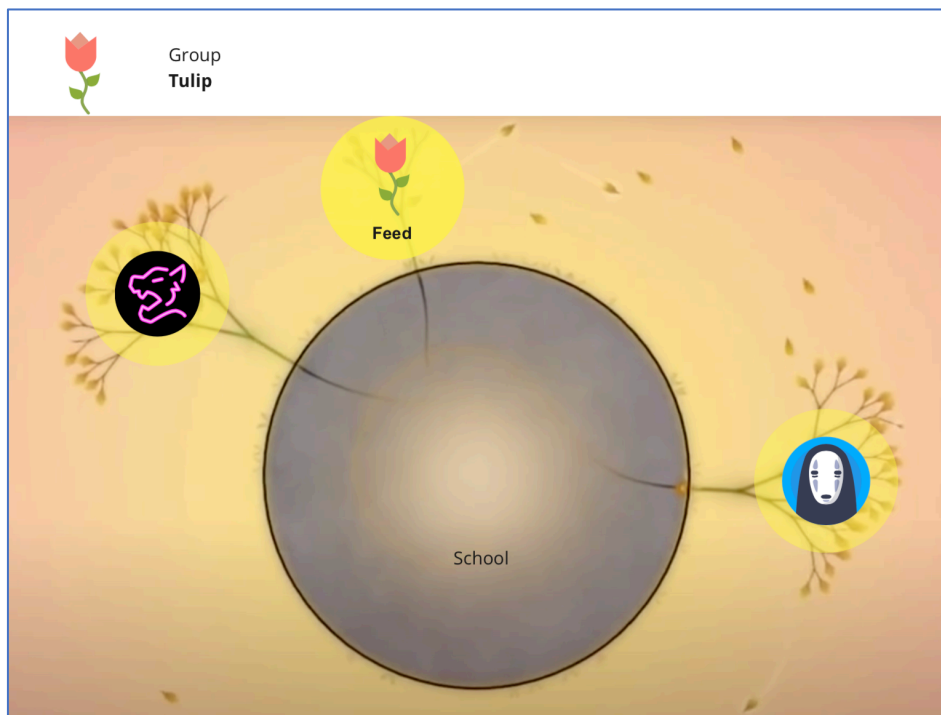
Plants

<Desired interaction>

I want the users to be motivated to care about indoor climate as they care about plants. They will interact with a branch of the plant as a group and the plant represents the whole school. So users can see how other groups' branches are growing and have the motive to cultivate a flourishing branch from a collective perspective. In order to cultivate the branch, users should take actions and gain energy points to feed the branch. The more energy it's fed with, the more flourishing it will be. The actions are about making a better indoor climate, so after achieving the action goal users can gain energy points and have a positive impact on indoor climate in reality simultaneously. Only different objectives of activities are provided, like lowering the temperature (because the high temperature in reality), together with the negative effect of current indoor climate on users, like high temperature increasing fatigue, to motivate users to take actions.

<Feedback>

1. compared to animals, plants make people less motivated. Animals are more friendly.
2. it might make people feeling shaming that they aren't doing good enough from the overview.
3. the visualization of different groups is good to see how every group is doing
4. it works more for motivated students.
5. more impactful illustrations of consequences are better

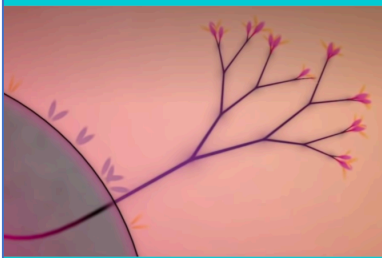




Group
Tulip



1 points left



You haven't feed it for 10 days.
Now it needs 10 points energy to grow.



10 points

Feed

Gain energy points

Lower the temperature

The temperature in classroom 3 is higher than the comfortable temperature.

A high temperature increases fatigue and reduces concentration.

Accept



2 points

Lower the CO2 level

The CO2 concentration in classroom 4 is higher than the comfortable level.

A high CO2 concentration causes headaches, dizziness, difficulties concentrating.

Accept



2 points

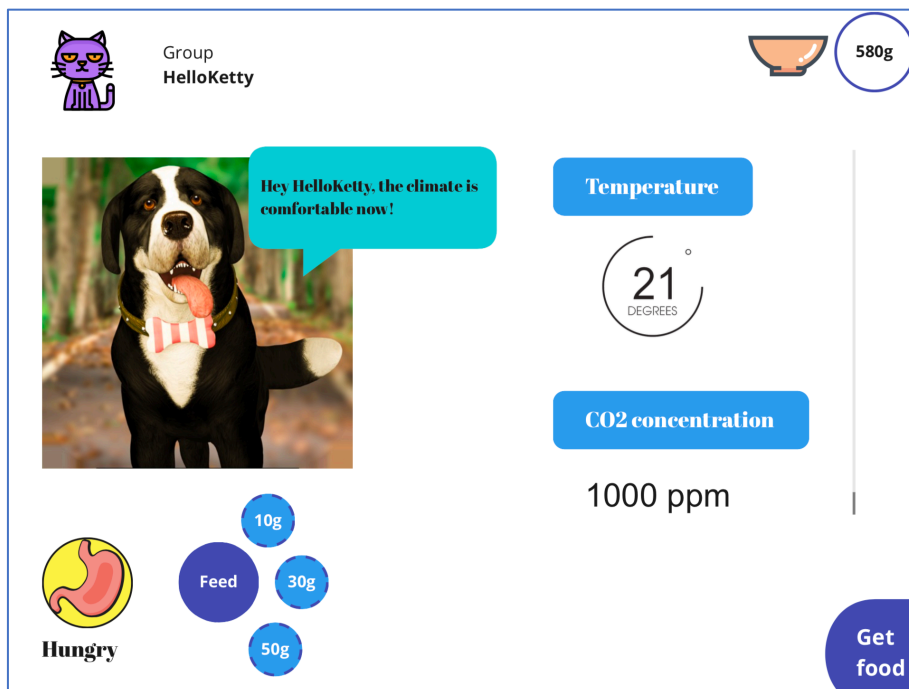
Pets

<Desired interaction>

I want the users to be motivated to care about sustainability as they care about pets. They will interact with virtual pets and feed them when they are hungry. Food for pets will be rewarded when users' energy use of last week is lower than average level. So users should take actions to earn the food. The sources of energy use will be reviewed and users know what they can work on. Besides, pets will not only show hunger but also react to factual indoor climate as same as humans' reaction to indoor climate, which arouses users' empathy. So users should care about indoor climate as well if they don't want pets to suffer.

<Feedback>

1. I like this concept of feeding a pet. it's interesting.
2. will my dog die if no food to feed?
3. younger students may prefer it.
4. the gamified system is not complete.
7. as a group, the energy use of a class cannot be in control.
8. it should be something that people can do as a group.
4. I have confidence to perform better than others because of the comparison with average energy use.
5. it lacks actions to do.
6. indoor climate part would rather be in classroom





Group
HelloKetty



580g

Energy use of last week No. 10



lighting



Average use

+ 30g



electrical device



+ 20g



heating



- 20g



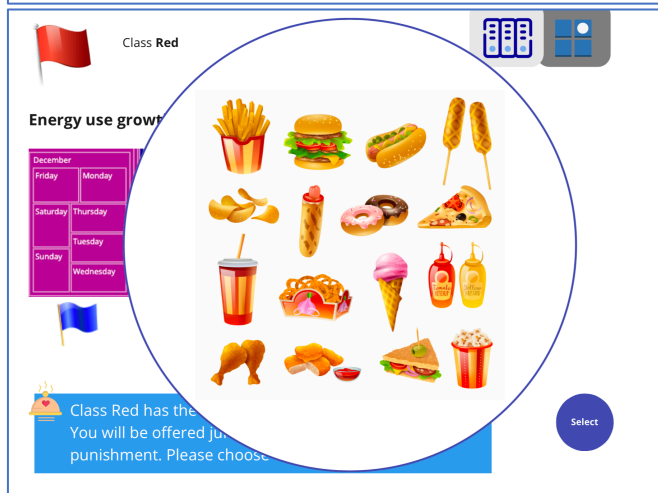
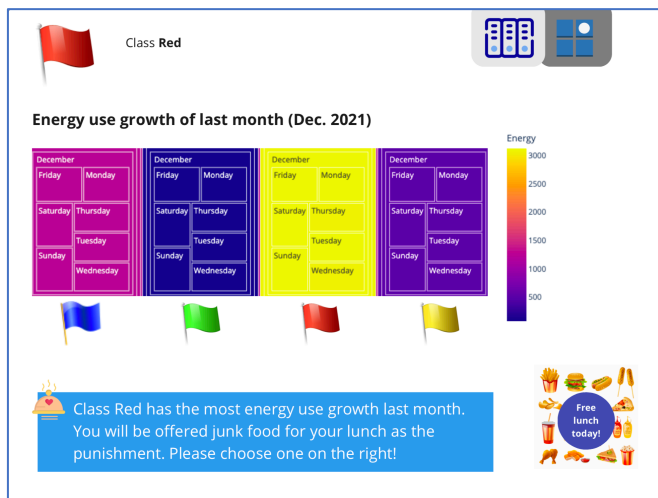
Food

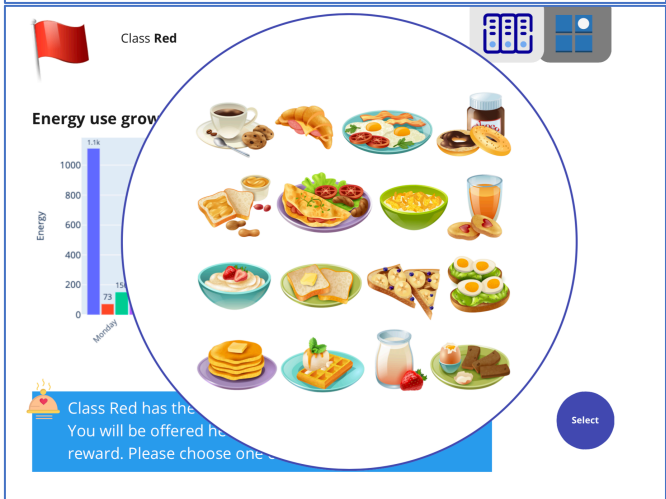
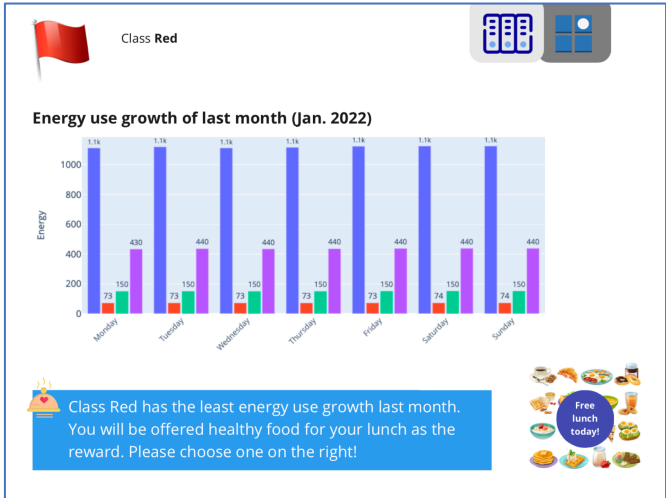
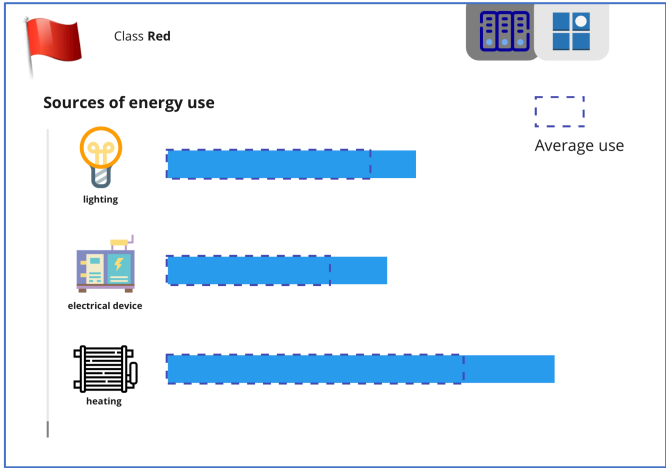
<Desired interaction>

I want the users to be motivated to care about sustainability as they care about their health. The energy use growth will be transformed into different types of dishes according to how much more or less energy they use comparing to average level. At the end of each month, every class will be rewarded to have a free lunch. The more energy use grows, the unhealthier lunch it will be. So users should take actions to save energy if they don't want to have junk food. The sources of energy use will be reviewed and users know what they can work on.

<Feedback>

1. students like junk food and it's free. better to only offer healthy food to the winner
4. it's good to have real reward like food.
2. I like competitions between classes
5. group based would be better as they have bigger motivation
3. nice that it gives hints for actions
6. nice to see progress and how it can be better
7. show the impact of saved energy
8. good visual of data in different days and comparison with other classes





Appendix 4

Design Cycle 2: Concepts

Action wheel


<Iteration>

In this group based concept, my colleagues liked the clear actions that informs people what to do to contribute to sustainability, which gives confidence to them. So this feature is kept and the impact of actions are enriched, covering both indoor climate and energy use.

The major iteration is adding an overview of total contribution of groups' actions. By showing the achievements that users have done, it gives users motivation to keep working on it. There are no games and competitions to motivate users here, a summary of actions done in a semester instead. It's another feature that differentiate itself from others.

Moreover, the reward in this concept is offering study credits to students according to their contributions to sustainability in school, which I took from another abandoned concept. I think it fits this concept well as they are both less entertaining and more academic.






Group
Lion

Number of activities participated


010

Energy saving of the month

010 KWh





Give the plants some water!
Walk to the janitor and ask for some water.
When you are ready, start the timer, and give as much plants water as possible!


10 mins


Start!

Impact


Save energy 0.3KWh for school.


Reduce CO2 concentration 50 ppm. The air becomes fresher.

Back




Group
Lion

Number of activities participated


011

Energy saving of the month

010 KWh




Turn off lights
Go to the first floor and turn off lights in Classroom 103 and 104.



5 mins

Start!


Impact


Save energy 1KWh for school.

Back




Group
Lion


End of semester summary

Actions

Number of activities participated **19**
Energy saving of the semester **10 KWh**

Reward

Earn study credits **5**

The activity list

- 1. Give the plants some water**
Save energy 0.3KWh
- 2. Turn off lights**
Save energy 1KWh
- 3. Turn off electrical devices**
Save energy 1.5KWh
- 4. Give the plants some water**
Save energy 0.3KWh
- 5. Turn off lights**

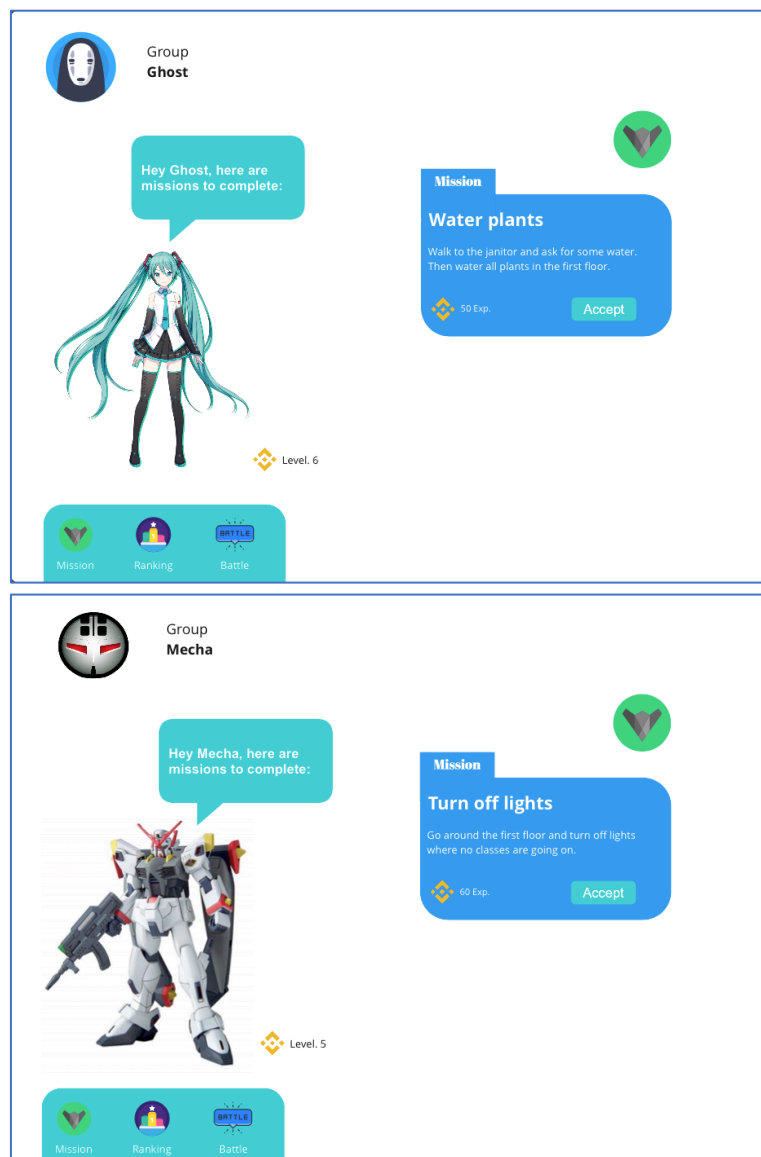
Character

<Iteration>


In this character concept, my colleagues liked the gamification feature as it motivates people to win the game as a group. But it shouldn't be too entertaining and time consuming, so I removed the character customization part. The explanation of actions is as same clear as another group based concept. Feedback shows it gives confidence to people.

A ranking system was added as well to compare groups in impact groups make in a period of time to show their achievements. It's important to link the victory in the game to the contribution in the real world. The real impact is meaningful to people while entertainment only is followed by boredom quickly.

Last but not least, the reward of the concept consists of an honorable announcement of a group photo, apart from revealing the ranking. So the group can feel proud of themselves, which motivate them further.





BATTLE


Group
Ghost


Level. 6

Level. 5

Group
Mecha




Ghost Win!




Mission


Ranking


BATTLE

Battle

Winner of the month

[See the ranking.](#)

Group
Ghost



Level. 6

Mission

Ranking

BATTLE

Battle

Impact from the winner

1. Give the plants some water

Exp. 50

Save energy 0.3KWh

2. Turn off lights

Exp. 60

Save energy 1KWh

3. Turn off electrical devices

Exp. 70

Save energy 1.5KWh

4. Give the plants some water

Exp. 50


Save energy 0.3KWh


5. Turn off lights


Exp. 60

Save energy 1KWh

Winner of the month

[See the ranking.](#)

Group
Ghost



Level. 6

Mission

Ranking

BATTLE

Battle

Impact from the winner

1. Give the plants some water

Exp. 50

Save energy 0.3KWh

2. Turn off lights

Exp. 60

Save energy 1KWh

3. Turn off electrical devices

Exp. 70

Save energy 1.5KWh

4. Give the plants some water


Exp. 50


Save energy 0.3KWh


5. Turn off lights


Exp. 60


Save energy 1KWh

No.1
Ghost

No.2
Mecha

No.3
Tulip

No.4
Ketty

No.5
Lion

Winner of the month



[See the ranking](#)



Ghost

Group photo



Impact from the winner

1. Give the plants some water

ces

water

Exp. 50
Save energy 0.3KWh

5. Turn off lights

Exp. 60
Save energy 1KWh



Mission



Ranking



Battle

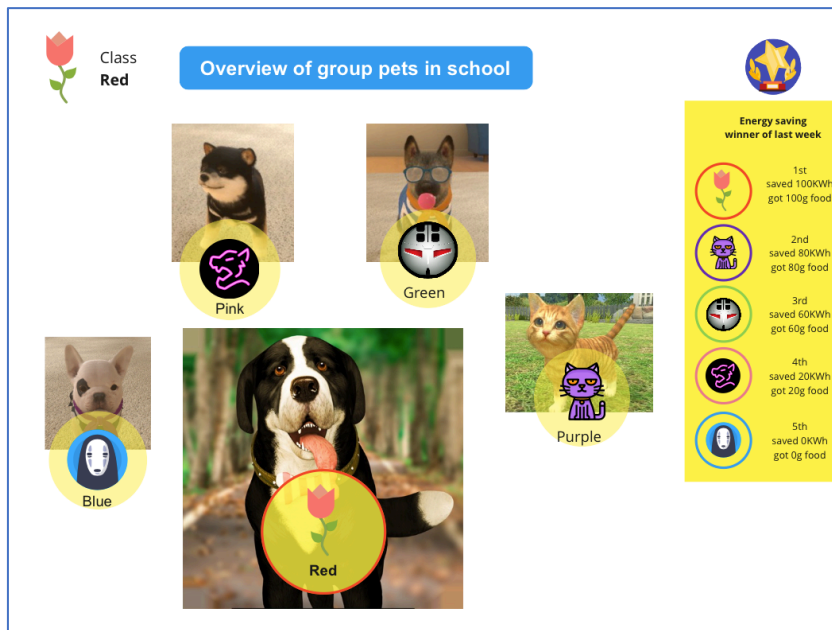
Pets

(This combines with plants)

<Iteration>

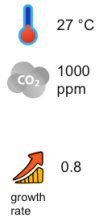
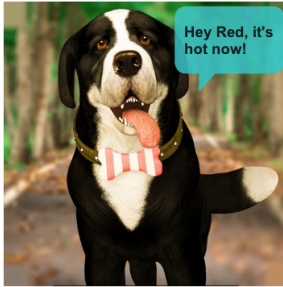
From the feedback of colleagues, I saw the concepts of plants and pets are complementary. The concept of feeding pets are more attractive to people than plants but the gamified system wasn't complete and people have no confidence if they feel the system isn't work, while the concept of growing plants has a well designated gamification system but the idea doesn't motivate people as much as the pets one. Therefore, I emerged them into one concept by taking the pros from both sides.

Besides, unlike the concept of food, the contents of the new pets concept include not only energy use data but also indoor climate related information to make the difference. To make sense of the system, the concept switched from group based to class based to fit the feature of indoor climate indication. Extended information such as effect of indoor climate on people's health and effect of energy use on sustainability in school are provided as well. Finally, to reward students, a ranking system are designed to show contributions on saving energy of all classes in a period of time.





Class
Red



580g



Hungry

Feed

High temperature

The temperature in your classroom is higher than the comfortable temperature. For your health and performance, please lower it.



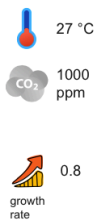
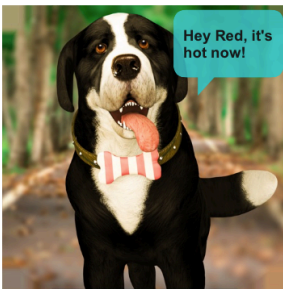
A high temperature increases fatigue and reduces concentration.

Know more about advices

Energy
use



Class
Red



580g



Hungry

Feed

High temperature

The temperature in your classroom is higher than the comfortable temperature. For your health and performance, please lower it.



A high temperature increases fatigue and reduces concentration.

Know more about advices



1. open windows and doors in the break.
2. go outside of classroom in the break.

Energy
use



Class
Red



Energy use of last week (No. 10)

Average use



lighting



electrical device



heating



Indoor
climate



Class
Red



Energy use of last week (No. 10)

Average use



lighting



electrical device



heating



Heating consumption is 40
KWh more than average use
in school last week. Let's
save some heating energy
next week!

Indoor
climate

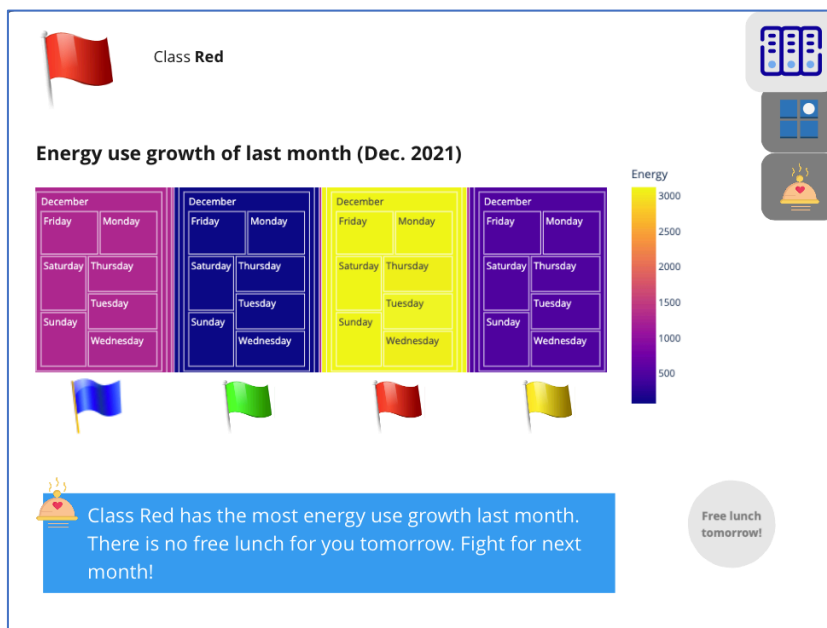
Food

<Iteration>

From the feedback of colleagues, it's good to have real reward of food. And it's good to have competitions between classes. Both features provide motivations to them.

However, the most common comments on this food concept is the doubt of providing free food to every class and especially use junk food as a punishment. The feedback to that is almost the same - secondary school students probably like to have junk food no matter how unhealthy it is. So the major iteration I did on this concept is to change the idea of 'every class have free food including healthy and junk food' to the idea of 'only the best winner class have free food', which makes it to be more like a desired reward.

Apart from that, I keep the contents of energy consumption and related factors. But the contents of solutions and effects of actions as the input from colleagues are not considered in this iteration because I want to differentiate it from other concepts below in terms of contents.





Class Red



Sources of energy use



lighting



electrical device



heating



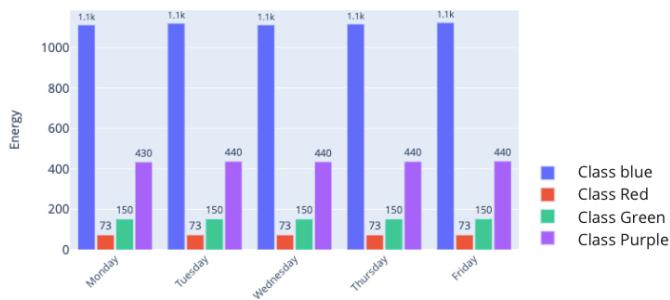
Average use



Class Red




Energy use growth of last month (Jan. 2022)



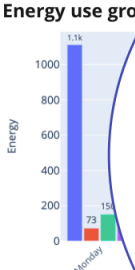
Class Red has the least energy use growth last month.
You will be offered free food for lunch tomorrow.
Please choose one on the right and claim it tomorrow!







Class Red




Energy use grows






Class Red has the
You will be offered he
reward. Please choose one

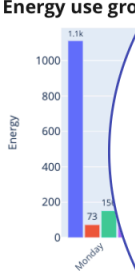
Select







Class Red

Energy use grows







Order received.



Class Red has the
You will be offered he
reward. Please choose one


Select






Class Red

Your free lunch order (Jan. 2022)







Change

Your free lunch order (Aug. 2021)



Free lunch tomorrow!





Pledge

<Iteration>

The feedback from my colleagues to this concept is generally negative. The concept is based on the idea of self-reporting. But people wouldn't either report indoor climate in class afterwards or sustainable actions afterwards. It might work in the scenario during class when students use it to report their thermal comfort instantly. And teachers can see students' reactions immediately and react to them. Unfortunately, I design the scenario outside of classrooms and I decided not to continue the concept. But it can be further developed for the scenario in class in the ENERGE team.

Cycle 2: Prototyping test

Four prototypes were tested online with 3 participants (two 18 years old, one 12 years old) and feedback gathered by interviews to know how the prototypes affect people's motivation and confidence in sustainable behavior. For every participant, the order of the prototypes shown was different to avoid bias from test process. Interviews were conducted on a provided Miro board and participants were asked to give qualitative feedback. This process was supported by the PrEmo tool (Laurans & Desmet, 2017) to help participants express the emotions felt about prototypes.

Process:

1. **Introduction:** explaining what the test will be about and scenarios
2. **Warming up:** asking several questions related to participants' basic information
3. **Testing:** testing one prototype while collecting comments on Miro at the same time
4. **Interview:** asking questions and collecting ideas
5. **Repetition:** testing next prototype and interviewing again
6. **Co-design:** after going through all concept, designing an ideal one

Questions asked during the interview:

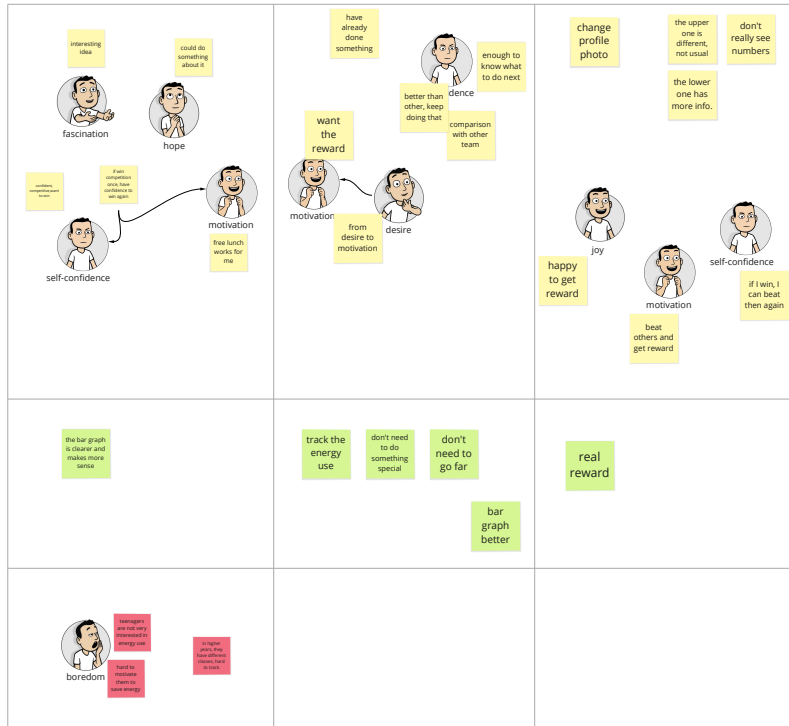
1. How do you feel the interaction?
2. What do you like/dislike about it?
3. Does it motivate you to act?
4. What makes you feel motivated?
5. Does it give you confidence to take actions?
6. What makes you feel confident?

Analysis:

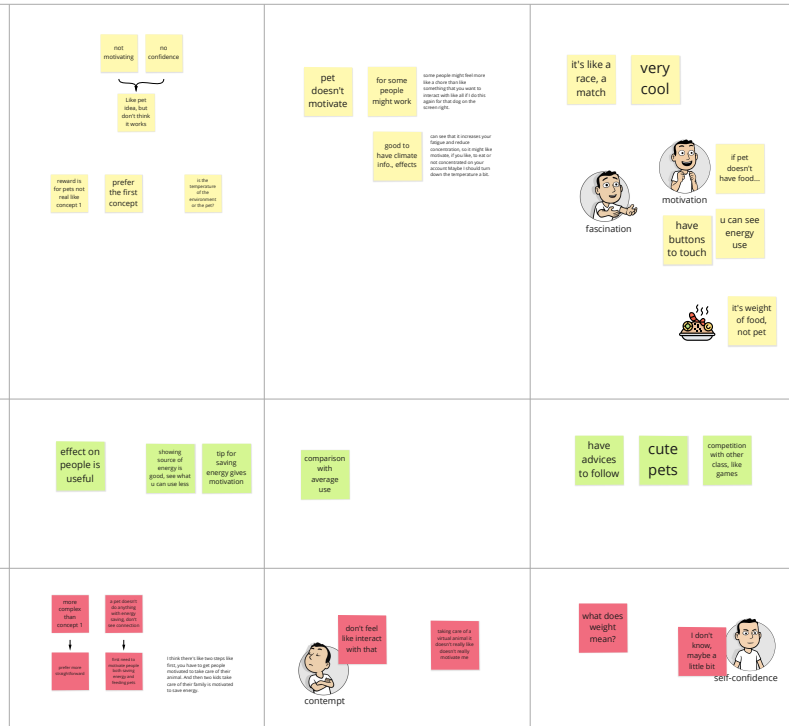
The feedback of participants was combined and clustered into positive, neutral and negative feedback towards each prototype and color coded to have quick viewability.

The features participants used in the co-design were analyzed in the matrix of different features to find a pattern.

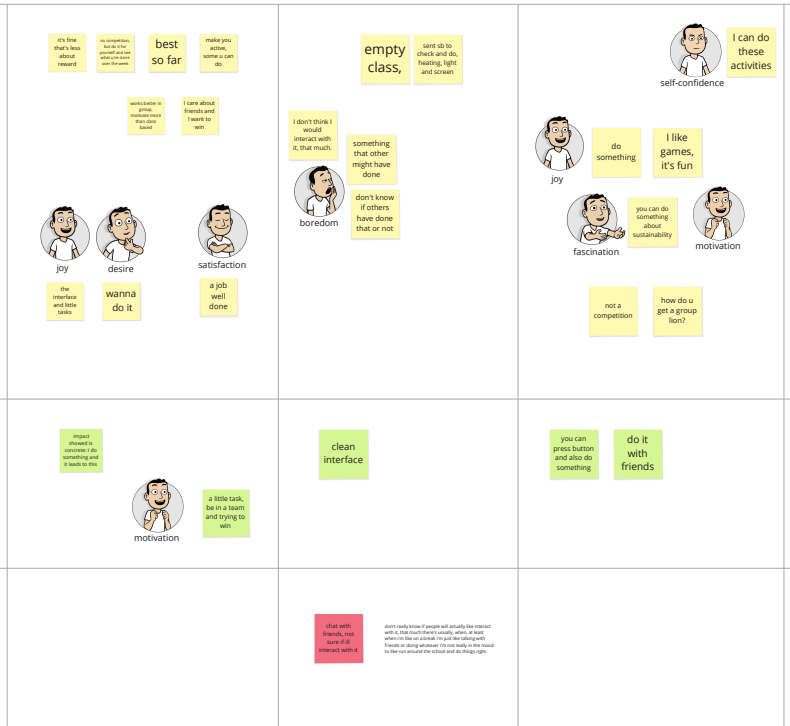
Concept 1 - food



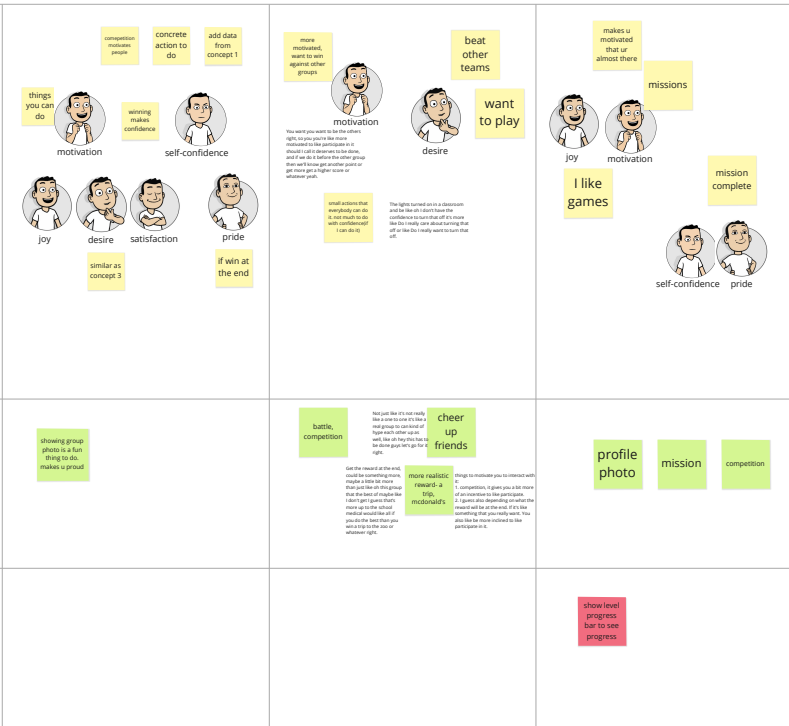
Concept 2 - pets



Concept 3 - action wheel

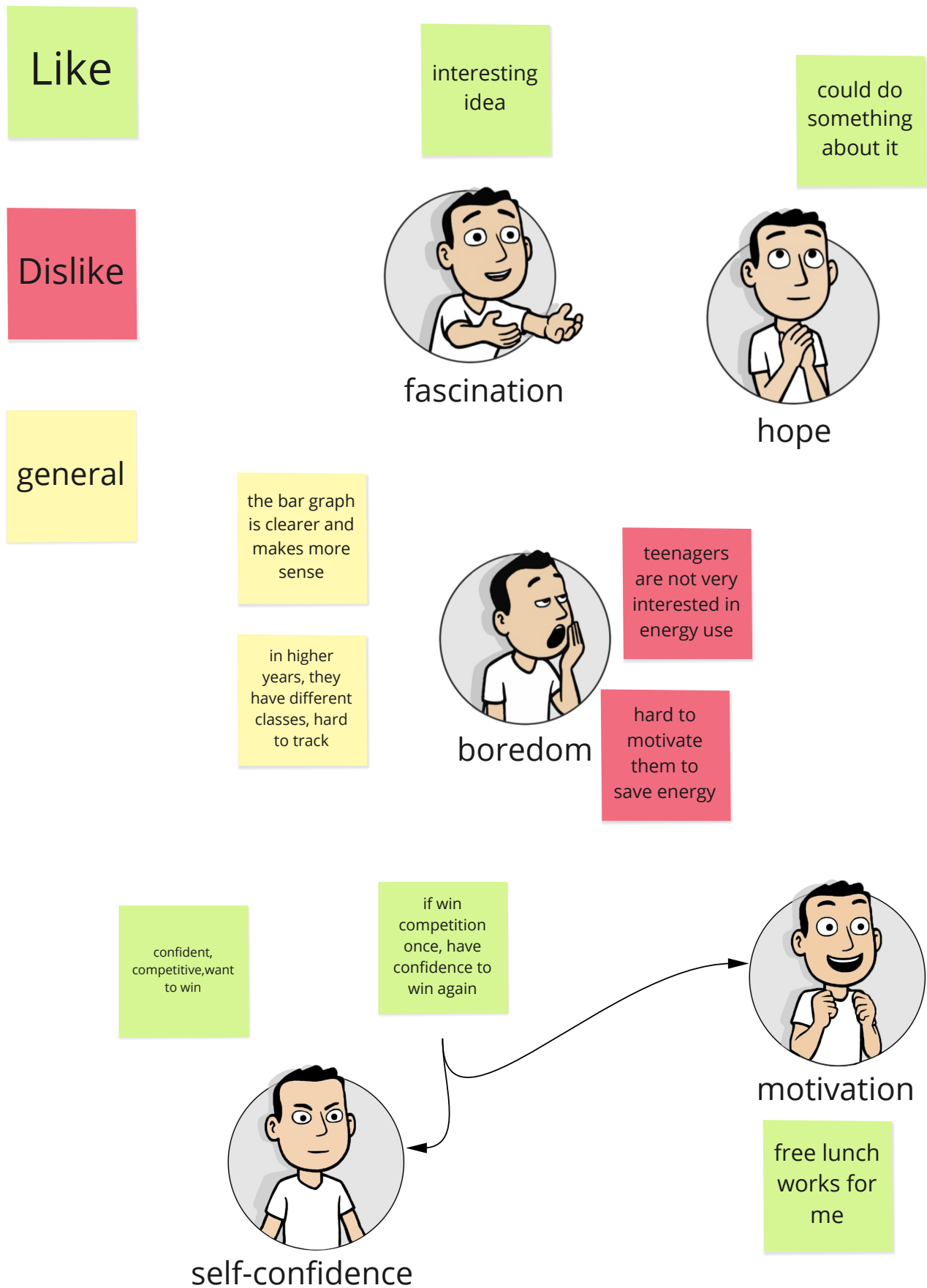


Concept 4 - character



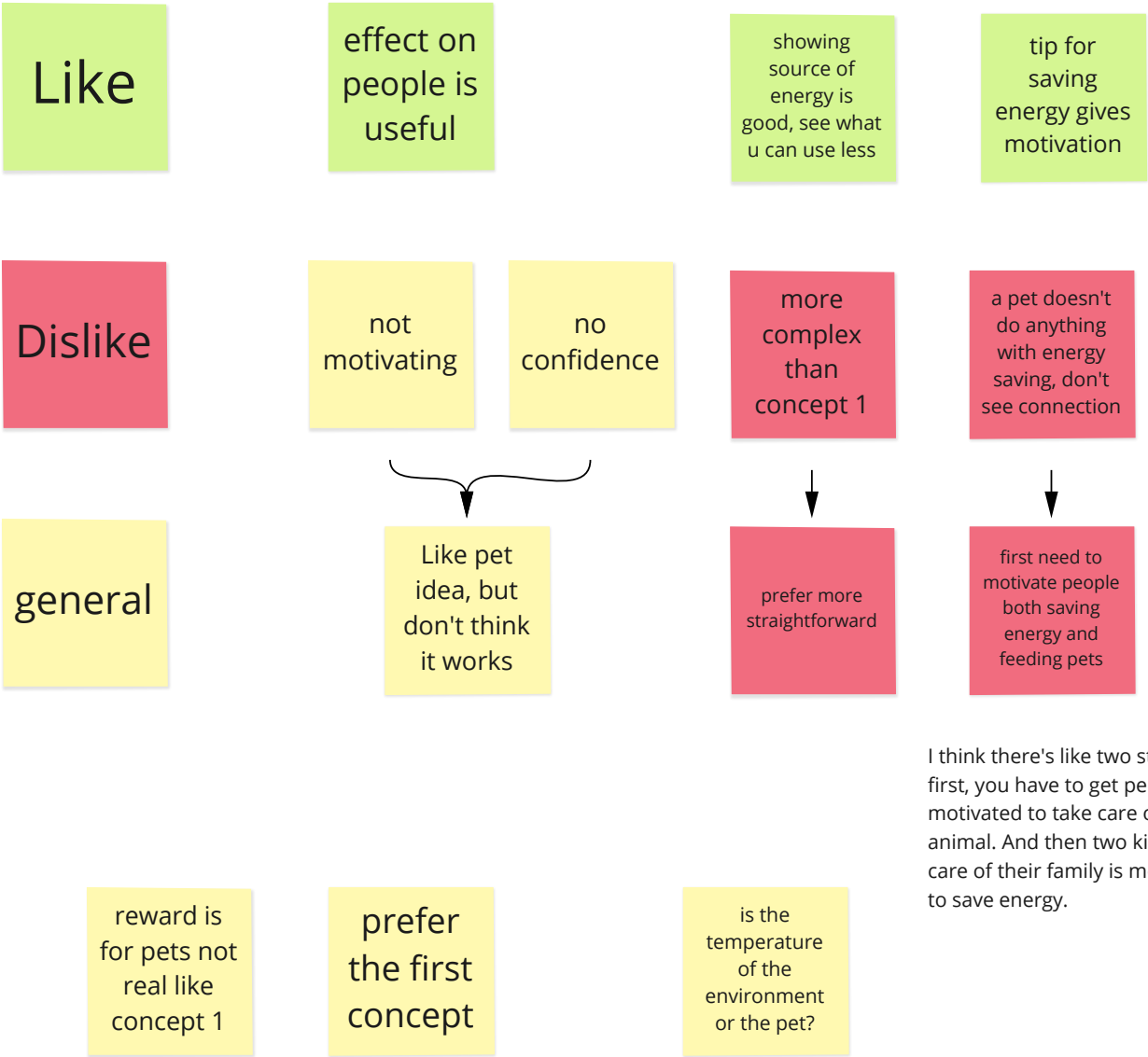
Prototype test: Cycle 2 - participant 1

Concept 1
food



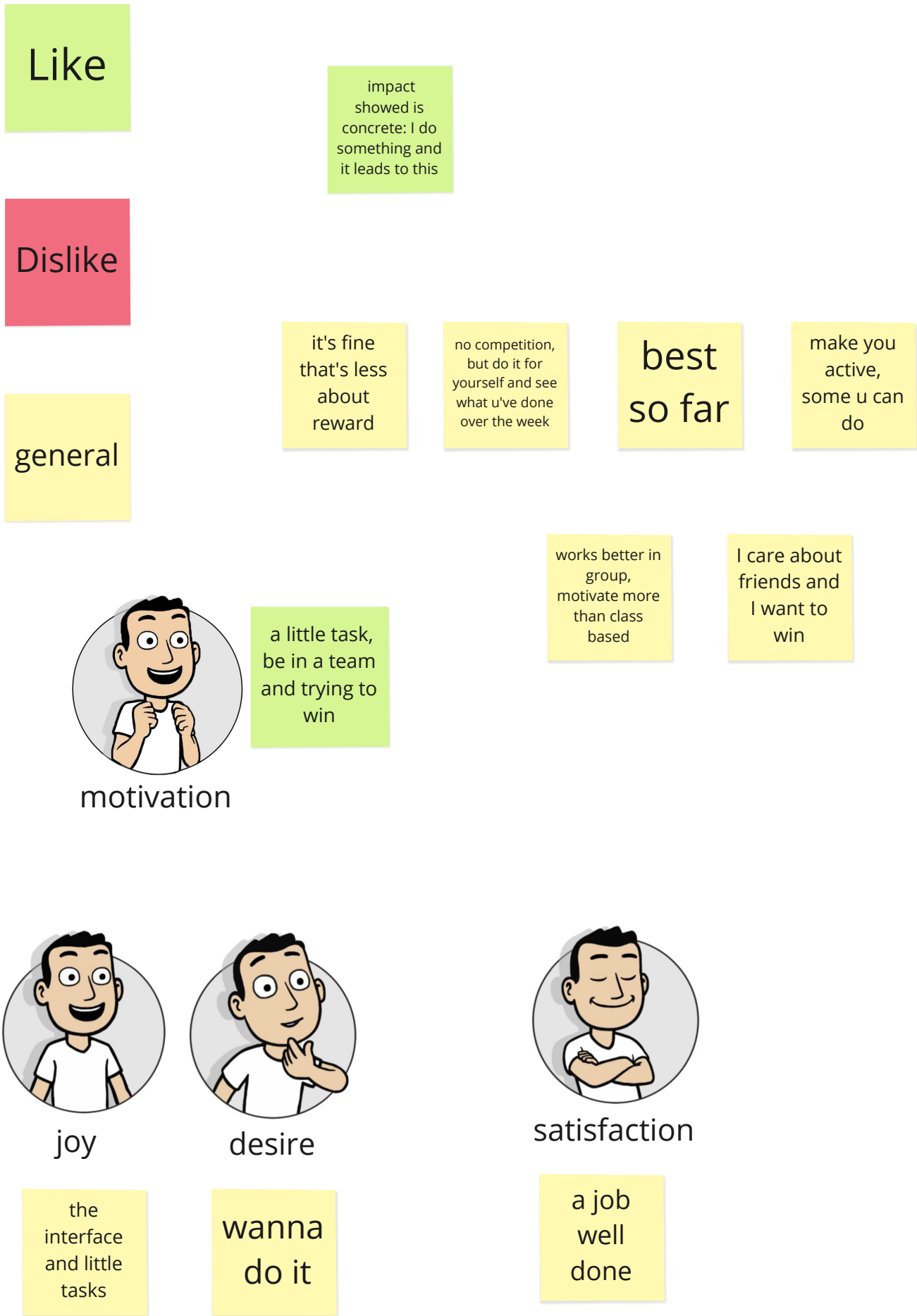
Prototype test: Cycle 2 - participant 1

Concept 2
pets



Prototype test: Cycle 2 - participant 1

Concept 3
action
wheel



Prototype test: Cycle 2 - participant 1

Concept 4
character

Like

showing group
photo is a fun
thing to do.
makes u proud

Dislike

general

comepetition
motivates
people

concrete
action to
do

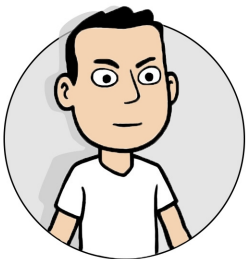
add data
from
concept 1

things
you can
do

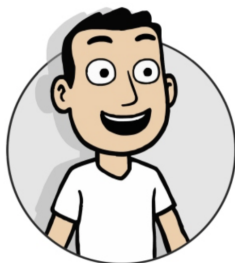


motivation

winning
makes
confidence



self-confidence



joy



desire



satisfaction



pride

similar as
concept 3

if win at
the end

Prototype test: Cycle 2 - participant 2

Concept 1
food

like

track the
energy
use

don't need
to do
something
special

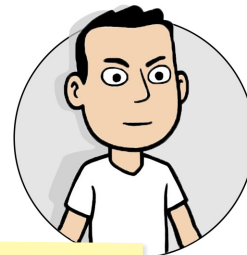
don't
need to
go far

dislike

With this it's just like oh he's like kind of exists and it just tracking your your stats. And then, if you see like a way to like kind of improve like your energy use or. Something like that, then you can go to like make that decision in the moment and not like Oh, I have to go do this thing it's like oh i'm already doing this thing and I can just kind of slightly change how to do it, or like think about an extra thing to like improve how my energies used.

general

have
already
done
something



enough to
know what
to do next

better than
other, keep
doing that

dence

comparison
with other
team

want
the
reward



motivation

from
desire to
motivation



desire

bar
graph
better

Because you can kind of instantly see like he was the highest energy consumption or like you use it the most energy and with the top one you have to like jackal which got our is which are which color is how much energy. it's it's a bit like more annoying to me to like check that first and then go discover means now this column it's not it's a lot easier, do you see like Oh, they have a longer bar so they mean means they've used more energy right yeah.

Prototype test: Cycle 2 - participant 2

Concept 2
pets

like

comparison
with
average
use

dislike

taking care of a
virtual animal it
doesn't really like
doesn't really
motivate me

general

pet
doesn't
motivate

for some
people
might work

some people might feel more
like a chore than like
something that you want to
interact with like all if I do this
again for that dog on the
screen right.

good to
have climate
info., effects

can see that it increases your
fatigue and reduce
concentration, so it might like
motivate, if you like, to eat or
not concentrated on your
account Maybe I should turn
down the temperature a bit.

don't feel
like interact
with that



contempt

Prototype test: Cycle 2 - participant 2

Concept 3
action
wheel

like

clean
interface

dislike

chat with
friends, not
sure if ill
interact with it

don't really know if people will actually like interact with it, that much there's usually, when, at least when i'm like on a break i'm just like talking with friends or doing whatever i'm not really in the mood to like run around the school and do things right.

general

empty
class,

sent sb to
check and do,
heating, light
and screen

I don't think I
would
interact with
it, that much.

something
that other
might have
done



boredom

don't know
if others
have done
that or not

Prototype test: Cycle 2 - participant 3

Concept 1
food

general

change
profile
photo

the upper
one is
different,
not usual

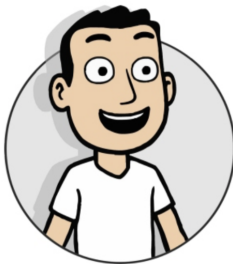
don't
really see
numbers

like

real
reward

the lower
one has
more info.

dislike



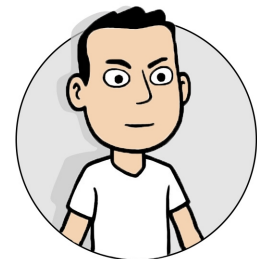
joy

happy
to get
reward



motivation

beat
others and
get reward



self-confidence

if I win, I
can beat
then again

Prototype test: Cycle 2 - participant 3

Concept 2
pets

general

it's like a
race, a
match

very
cool

like

have
advices
to follow

cute
pets

competition
with other
class, like
games

dislike

what does
weight
mean?



fascination



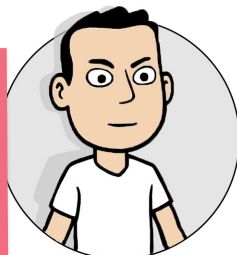
motivation

if pet
doesn't
have food...

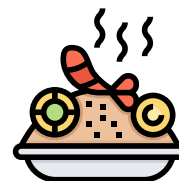
have
buttons
to touch

u can see
energy
use

I don't
know,
maybe a
little bit



self-confidence



it's weight
of food,
not pet

Prototype test: Cycle 2 - participant 3

Concept 3
action
wheel

general

not a
competition

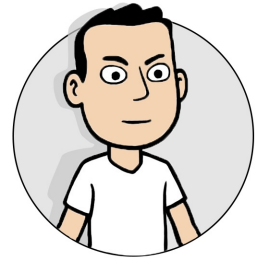
how do u
get a group
lion?

like

you can
press button
and also do
something

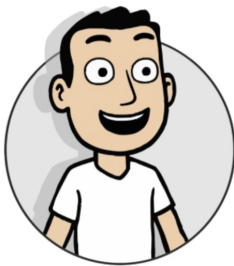
do it
with
friends

dislike



self-confidence

I can do
these
activities



joy

do
something

I like
games,
it's fun



fascination

you can do
something
about
sustainability



motivation

Prototype test: Cycle 2 - participant 3

Concept 4
character

general

like

profile
photo

mission

competition

dislike

show level
progress
bar to see
progress

makes u
motivated
that ur
almost there

missions

mission
complete

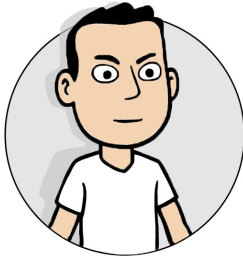


joy



motivation

I like
games



self-confidence



pride

Prototype test: Cycle 2 - participant 2

Concept 4
character

like

battle,
competition

Not just like it's not really like a one to one it's like a real group to can kind of hype each other up as well, like oh hey this has to be done guys let's go for it right.

cheer
up
friends

dislike

Get the reward at the end, could be something more, maybe a little bit more than just like oh this group that the best of maybe like I don't get I guess that's more up to the school medical would like all if you do the best than you win a trip to the zoo or whatever right.

more realistic
reward- a
trip,
mcdonald's

general

small actions that
everybody can do
it. not much to do
with confidence(if
I can do it)

The lights turned on in a classroom and be like oh I don't have the confidence to turn that off it's more like Do I really care about turning that off or like Do I really want to turn that off.

things to motivate you to interact with it:

1. competition, it gives you a bit more of an incentive to like participate.
2. I guess also depending on what the reward will be at the end. If it's like something that you really want. You also like be more inclined to like participate in it.

more
motivated,
want to win
against other
groups



motivation

You want you want to be the others right, so you you're like more motivated to like participate in it should I call it deserves to be done, and if we do it before the other group then we'll know get another point or get more get a higher score or whatever yeah.

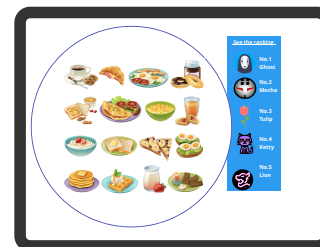
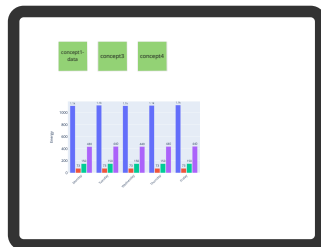
beat
other
teams



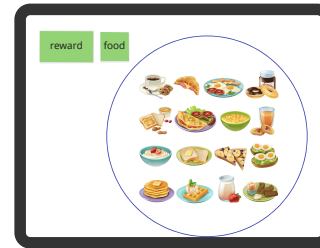
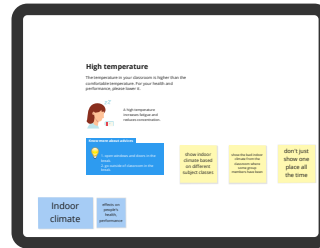
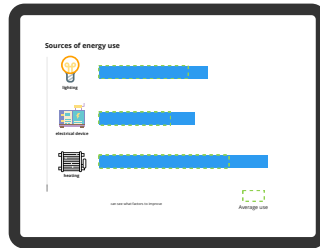
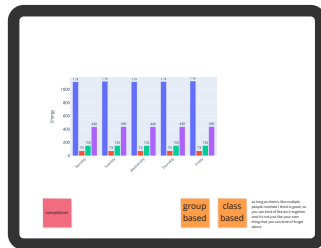
desire

want
to play

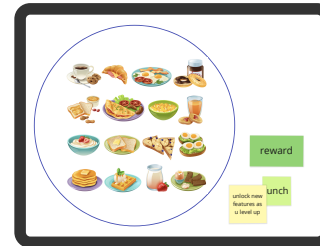
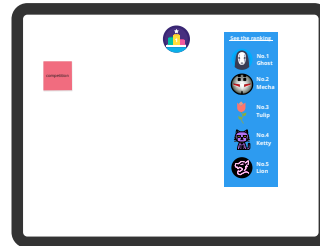
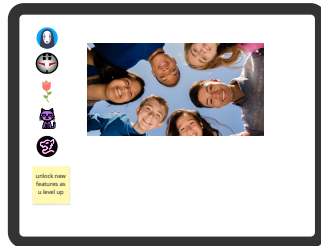
codesign-participant1



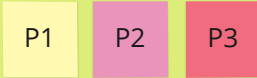


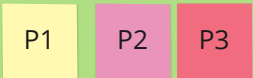










codesign-participant2



codesign-participant3



basis	Class based 	Group based 		
form	competition & ranking 	actions 		
reward	earning credits 	food 	customization 	honorable announcement 
indoor climate	Indoor climate data 	Indoor climate quality 	effects on people's health, performance 	Related factors (e.g. heating/ ventilation) 
energy use	Energy use data 	effects on sustainability in school 	Sources of energy use 	goal and solution 

Appendix 5



Promotivate

Login

Promotivate

Group name



Mecha

Group members



Paul
Grade 12



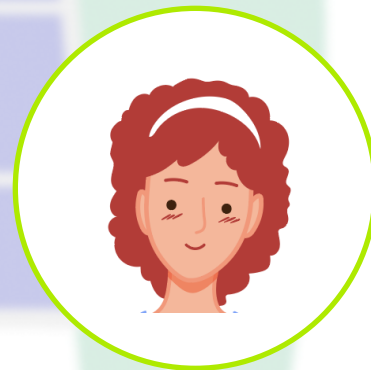
May
Grade 12



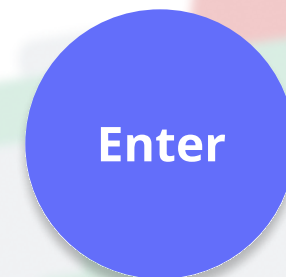
Peter
Grade 12



Lee
Grade 12



Anna
Grade 12





Group
Mecha



Group



Action

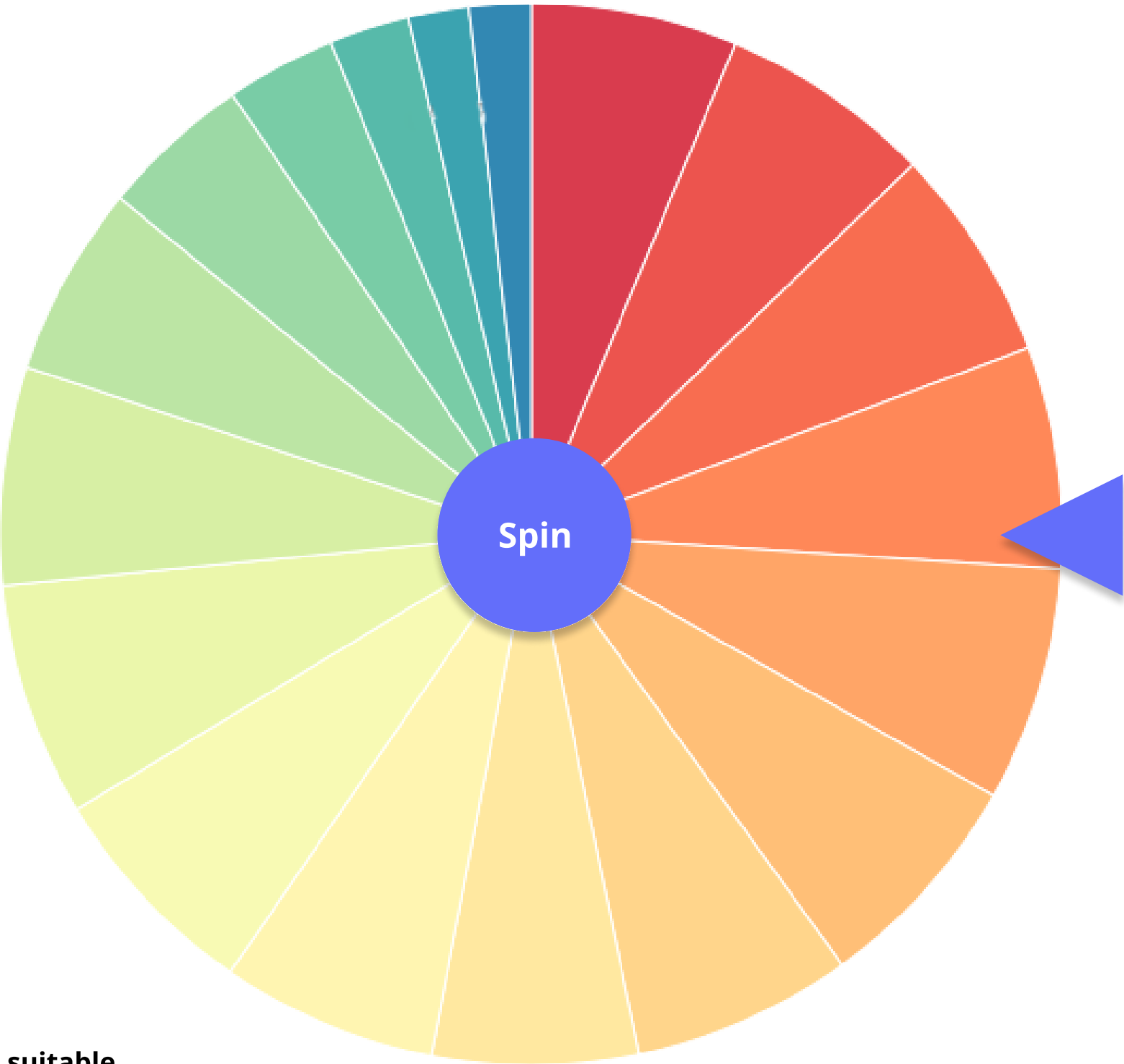


Ranking



Reward

Action wheel



The activity to do

Number of participants suitable

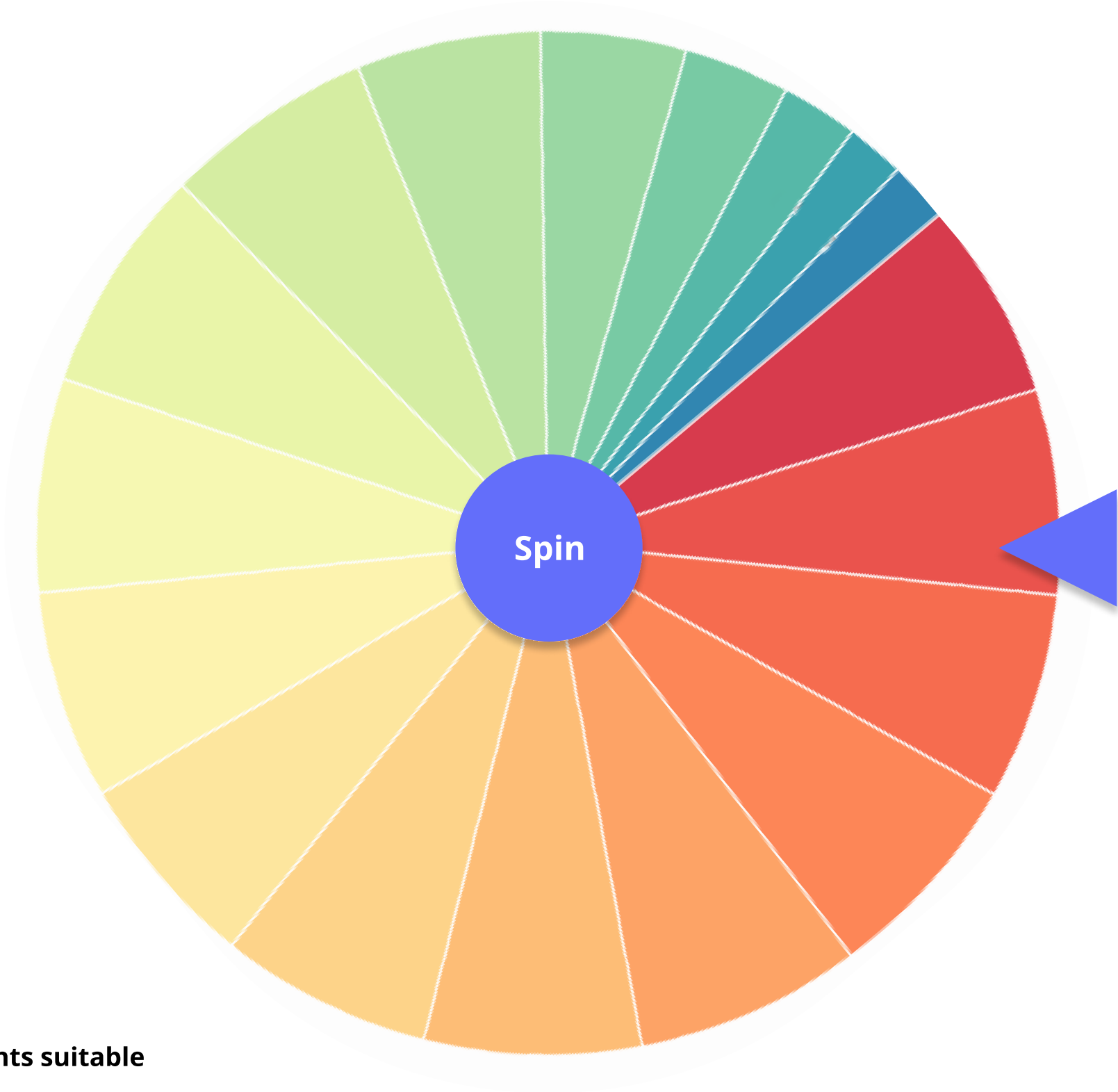


2 people

6 people



Action wheel



Number of participants suitable



2 people

6 people

Give the plants some
water!

Suitable for 5 people

Enter



Give the plants some water!

Walk to the janitor to get some water. And water the plants in the ground floor and first floor. When you are ready, start the timer.

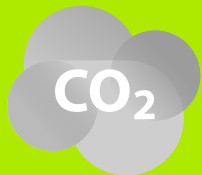
Suitable for 5 people

Impact



0.3 KWh

Energy saved for school.



50 ppm

CO2 concentration reduced. The air becomes fresher.



8 mins

Start!

Back



Give the plants some water!

Walk to the janitor to get some water. And water the plants on the ground floor and first floor. When you are ready, start the timer.

Suitable for 5 people

0

mins

Cancel

Done

Impact

0.3 KWh
Energy saved for school.

50 ppm
CO2 concentration reduced. The air becomes fresher.



8 mins



Give the plants some water!

Walk to the janitor to get some water. And water the plants in the ground floor and first floor. When you are ready, start the timer.

Suitable for 5 people

Impact



Your impact has been added to your total saved energy in this month.
See it in the Ranking.



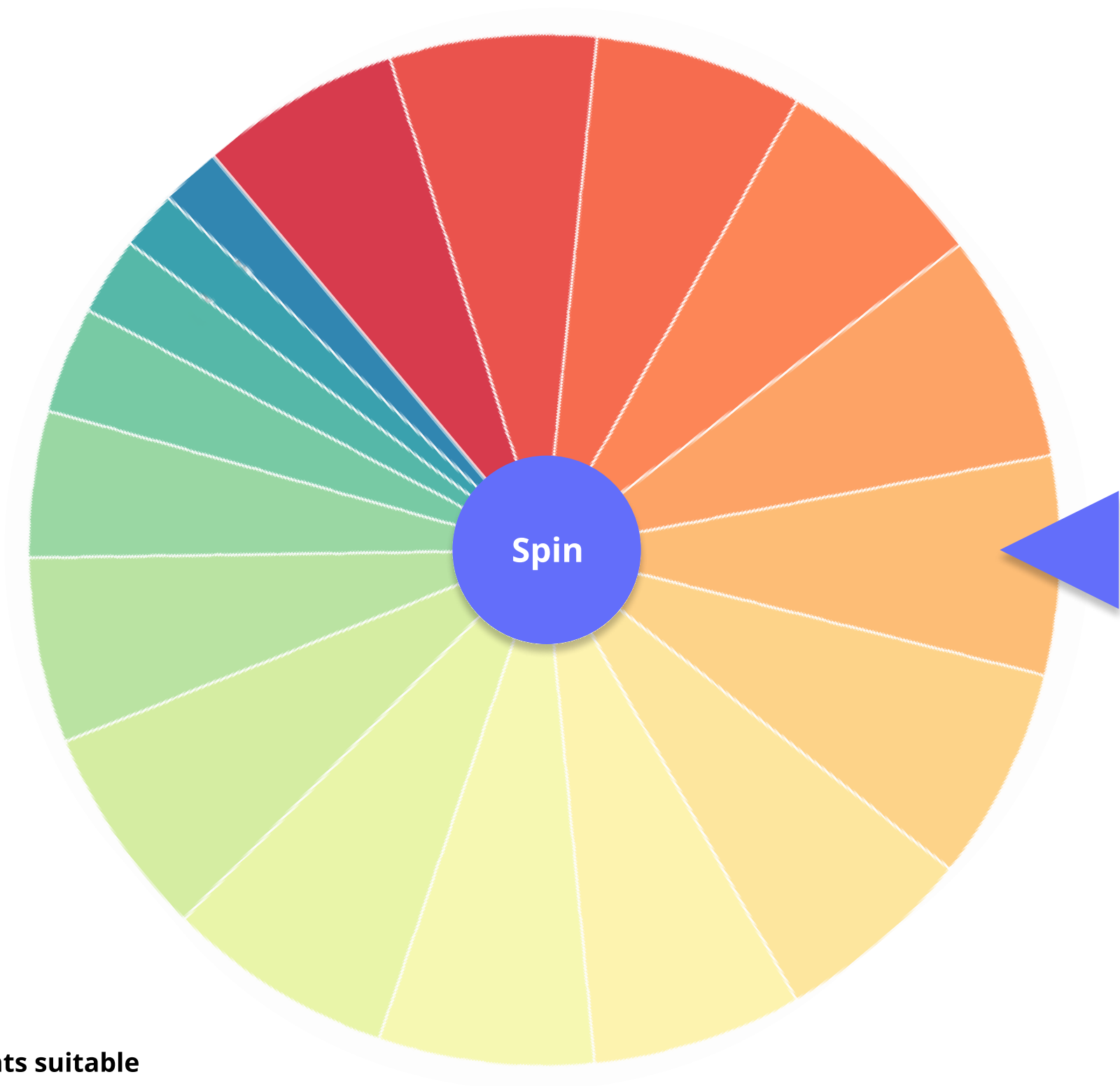
8 mins

Start!





Action wheel



Turn off lights!

Suitable for 3 people

Enter

Number of participants suitable



2 people

6 people



Turn off lights!

There is no lesson in Classroom 103, 202 and 301 this afternoon but the lights are on.

Go to the 1st, 2nd and 3rd floor to turn off lights in Classroom 103, 202 and 301.

When you are ready, start the timer.

Suitable for 3 people



5 mins

Start!

Impact



1.0 kWh

Energy saved for school.

Back



Turn off lights!

There is no lesson in Classr
202 and 301 this afternoon
lights are on.
Go to the 1st, 2nd and 3rd f
turn off lights in Classroom
and 301.
When you are ready, start the timer.

Suitable for 3 people

0

mins

Cancel

Done

Impact

1.0

KWh

Energy saved for school.



5 mins



Turn off lights!

There is no lesson in Classroom 103, 202 and 301 this afternoon but the lights are on.
Go to the 1st, 2nd and 3rd floor to turn off lights in Classroom 103, 202 and 301.
When you are ready, start the timer.

Suitable for 3 people



5 mins

Start!

Impact

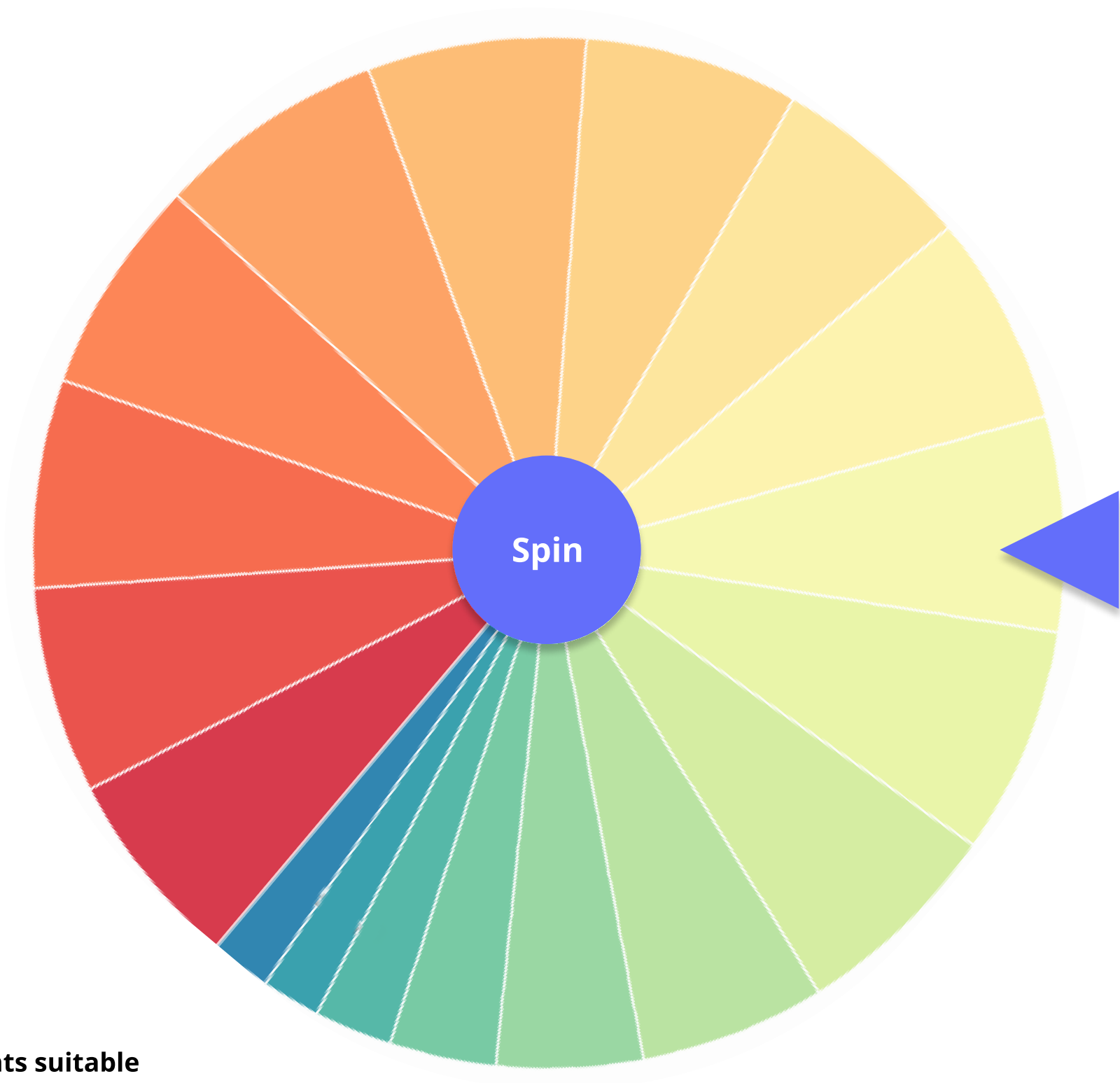


Your impact has been added to your total saved energy in this month.
See it in the Ranking.

Spin



Action wheel



Turn off devices!

Suitable for 2 people

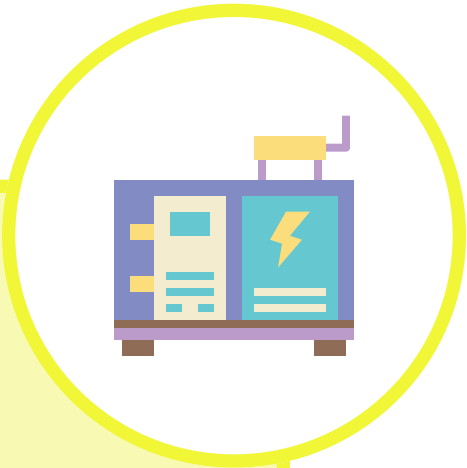
Enter

Number of participants suitable



2 people

6 people



Turn off devices!

There is no scheduled lesson after May’s class in Classroom 101 and Lee’s lesson in Classroom 201 from 10:00 to 13:30 , but the electrical devices are still on.
Go to the 1st and 2nd floor to turn off devices in Classroom 101and 201.
When you are ready, start the timer.


Suitable for 2 people



3 mins

Start!

Impact

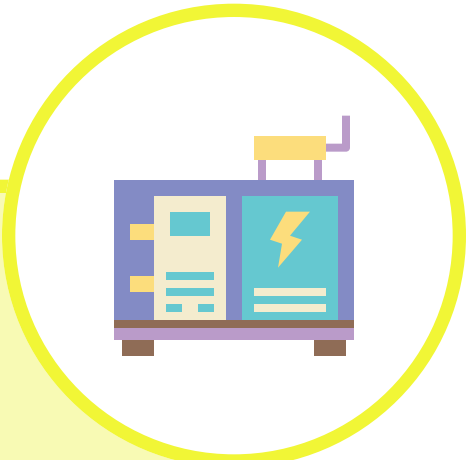


0.8

KWh

Energy saved for school.

Back



Turn off devices!

There is no scheduled lesson for May's class in Classroom 10. Lee's lesson in Classroom 201 is scheduled from 10:00 to 13:30, but the electrical devices are still on. Go to the 1st and 2nd floors and turn off devices in Classroom 10 and Classroom 201. When you are ready, start the timer.

Suitable for 2 people

0

mins

Cancel

Done

Impact

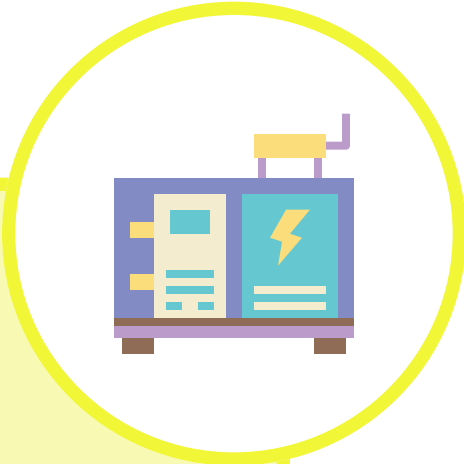
0.8

KWh

Energy saved for school.



3 mins



Turn off devices!

There is no scheduled lesson after May’s class in Classroom 101 and Lee’s lesson in Classroom 201 from 10:00 to 13:30 , but the electrical devices are still on.
Go to the 1st and 2nd floor to turn off devices in Classroom 101and 201.
When you are ready, start the timer.

Suitable for 2 people

Impact



Your impact has been added to your total saved energy in this month.
See it in the Ranking.



3 mins

Start!

Spin



Group
Mecha



Group



Action





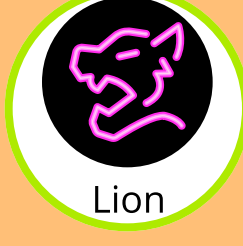


Ranking



Reward

Real-time ranking

1st place	 Mecha	<div></div> Saved energy 28KWh
2nd place	 Ghost	<div></div> Saved energy 23KWh
3rd place	 Tulip	<div></div> Saved energy 22KWh
4th place	 Ketty	<div></div> Saved energy 18KWh
5th place	 Lion	<div></div> Saved energy 8KWh


Winner of February 2022

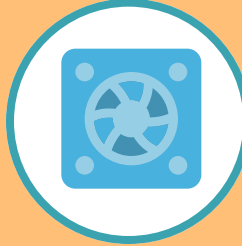
1st
place

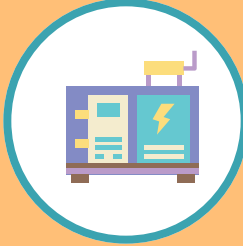
1 day to go


Free lunch!

Winner saved energy

lighting

ventilation

electrical
devices

plants



Group
Mecha



Group



Action





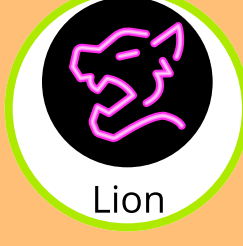


Ranking




Reward

Real-time ranking

1st place	 Mecha	<div></div> Saved energy 30KWh
2nd place	 Ghost	<div></div> Saved energy 25KWh
3rd place	 Tulip	<div></div> Saved energy 23KWh
4th place	 Ketty	<div></div> Saved energy 18KWh
5th place	 Lion	<div></div> Saved energy 8KWh

Winner of February 2022


1st place


Mecha

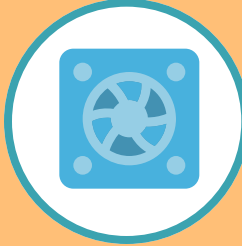
Saved energy 30KWh

Free lunch!

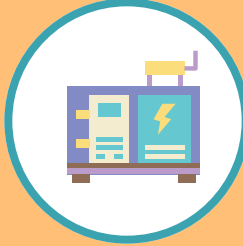
Winner saved energy


lighting


5KWh


ventilation

16KWh


electrical devices

5KWh


plants

4KWh



Group
Mecha



Group



Action



Ranking



Reward

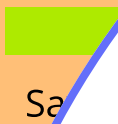
Real-time ranking

Winner of Febuary 2022

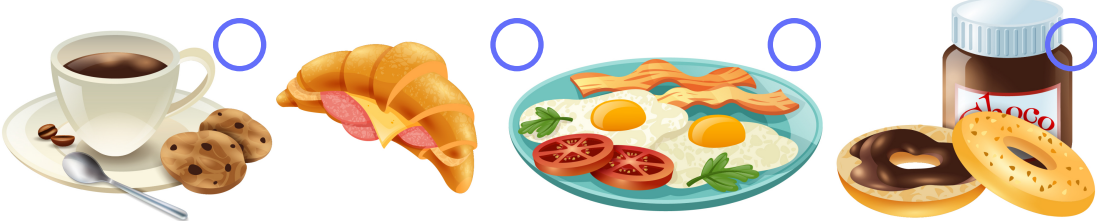
1st
place



Mecha



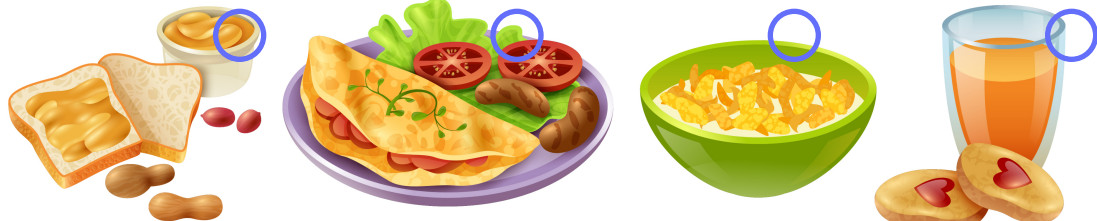
Sa



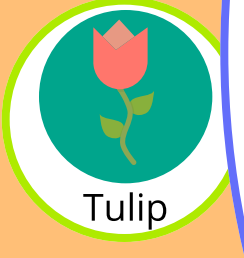
2nd
place



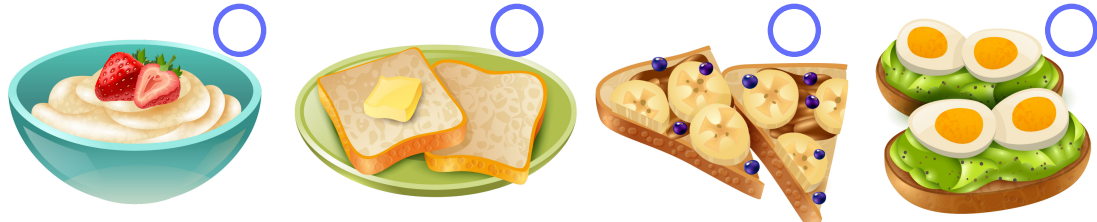
Ghost



3rd
place



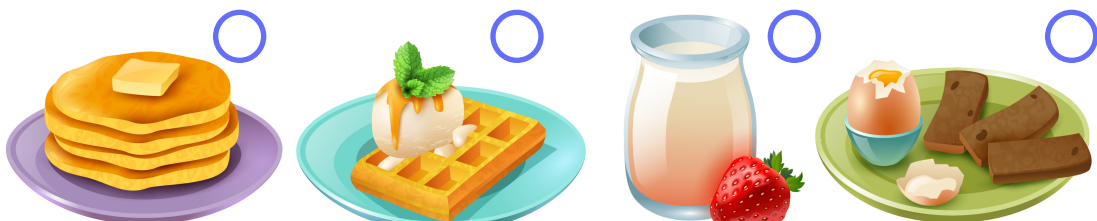
Tulip



4th
place



Ketty



5th
place



Lion



Saved ener

Saved energy 30KWh

ventilation



16KWh

plants



4K

Confirm



Group
Mecha



Group



Action



Ranking



Reward

Real-time ranking

Winner of February 2022

1st
place



Mecha

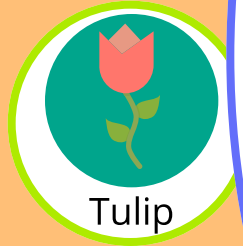
Sa

2nd
place



Ghost

3rd
place



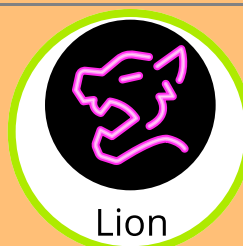
Tulip

4th
place



Ketty

5th
place



Lion

Saved energy



Saved energy 30KWh

ventilation

16KWh

plants

4KWh

Confirm



Real-time ranking

Winner of Febuary 2022

1st
place



Mecha



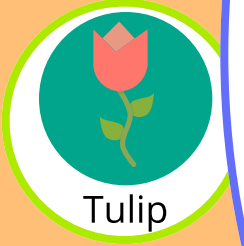
Sa

2nd
place



Ghost

3rd
place



Tulip

4th
place



Ketty

5th
place



Lion



Saved ener



Order
received.
Pick up
tomorrow.

Saved energy 30KWh

ventilation



16KWh

plants



4K

Go to
Reward



Group
Mecha



Group



Action



Ranking



Reward

Your free lunch order (Nov. 2021)

Pick up on 01.12.2021 at the canteen.



Your free lunch order (Aug. 2021)

Pick up on 01.09.2021 at the canteen.



Have other reward
ideas?



Group
Mecha



Group



Action



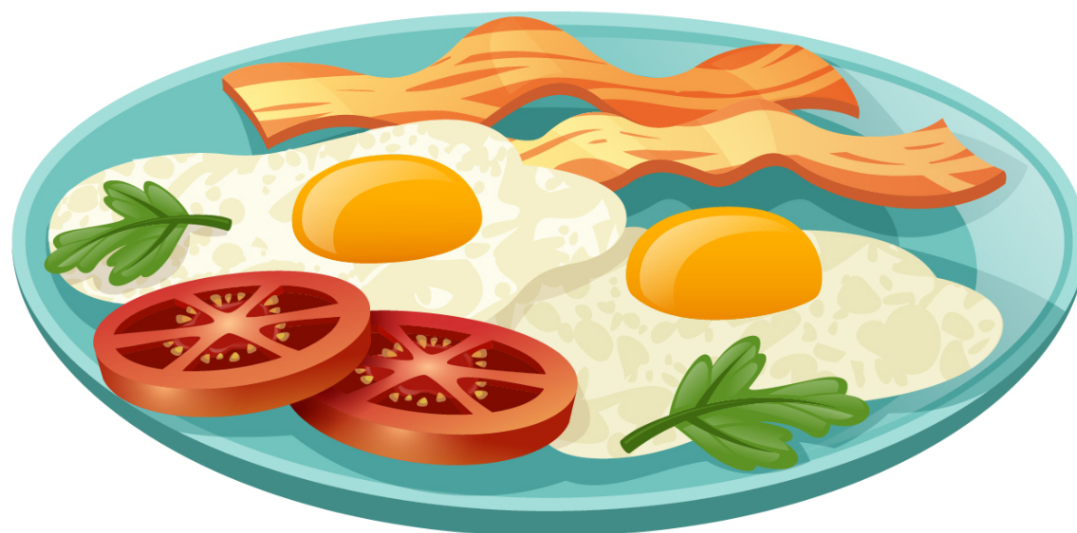
Ranking



Reward

Your free lunch order (Feb. 2022)

Pick up on 01.03.2022 at the canteen.



Change

Your free lunch order (Nov. 2021)

Pick up on 01.12.2021 at the canteen.



Have other reward
ideas?



Group
Mecha



Group



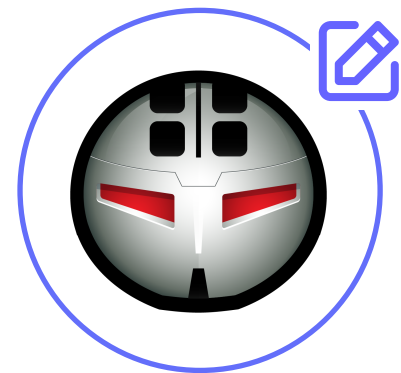
Action



Ranking



Reward



Mecha



Group members



Paul
Grade 12



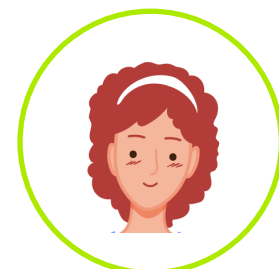
Noëlle
Grade 12



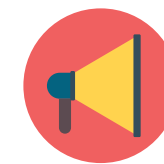
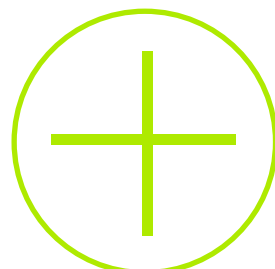
Peter
Grade 12



Lee
Grade 12



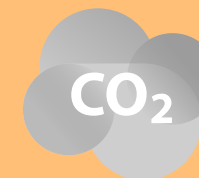
Anna
Grade 12



Notification

Hey Anna:

In the math class in the morning, the CO₂ concentration in your classroom was higher than the acceptable level. For your health and performance, please lower it.



The peak CO₂ concentration was 1300 ppm.



Know more about its effect on your health and advices



A mail to Paul



Group
Mecha



Group



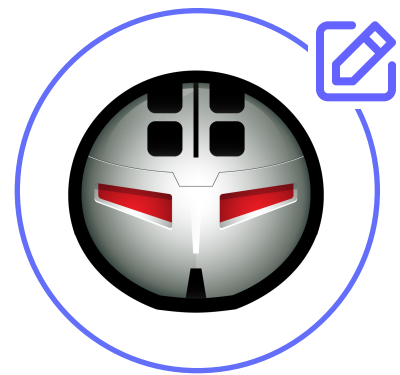
Action



Ranking



Reward



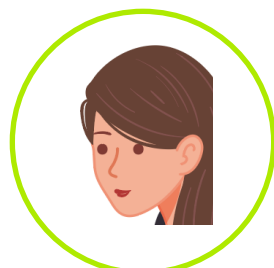
Mecha



Group members



Paul
Grade 12



Noëlle
Grade 12



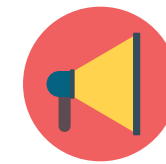
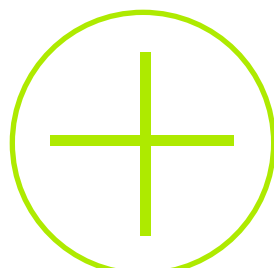
Peter
Grade 12



Lee
Grade 12



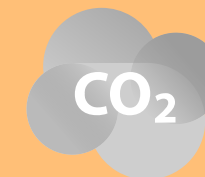
Anna
Grade 12



Notification

Hey Anna:

In the math class in the morning, the CO₂ concentration in your classroom was higher than the acceptable level. For your health and performance, please lower it.



The peak CO₂ concentration was 1300 ppm.



Its effect on your health and advices

A high CO₂ concentration causes symptoms of headaches, dizziness, difficulties concentrating, unpleasant odor.



Advices

1. open windows and doors in the break.
2. reduce number of people in the room.



A mail to Paul



Group
Mecha



Group



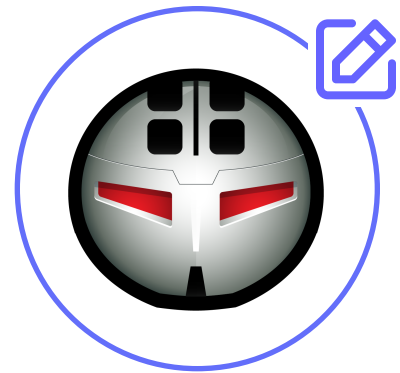
Action



Ranking



Reward



Mecha



Group members



Paul
Grade 12



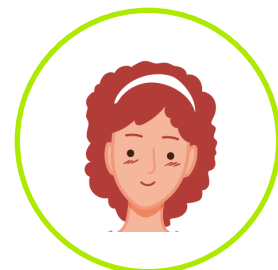
Noëlle
Grade 12



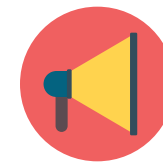
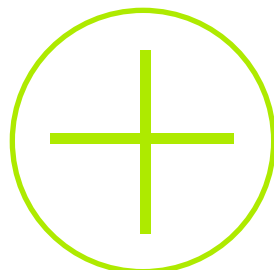
Peter
Grade 12



Lee
Grade 12



Anna
Grade 12



Notification



A mail to Anna

Hey Paul:

In the Physics class in the morning, the temperature in your classroom was higher than the comfortable level. For your health and performance, please lower it.



The peak temperature was 27 degree.



Know more about its effect on your health and advices



Group
Mecha



Group



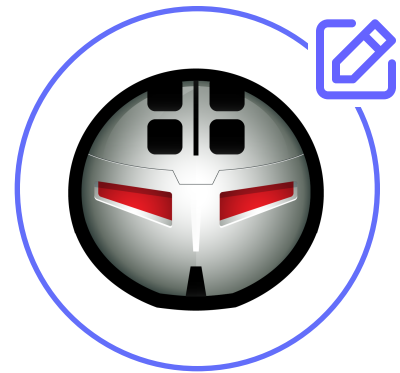
Action



Ranking



Reward



Mecha



Group members



Paul
Grade 12



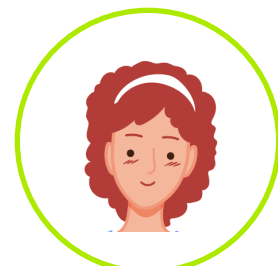
Noëlle
Grade 12



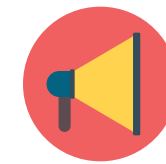
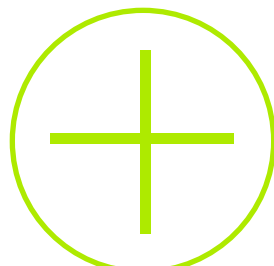
Peter
Grade 12



Lee
Grade 12



Anna
Grade 12



Notification



A mail to Anna

Hey Paul:

In the Physics class in the morning, the temperature in your classroom was higher than the comfortable level. For your health and performance, please lower it.



The peak temperature was 27 degree.



Its effect on your health and advices

A high temperature increases fatigue and reduces concentration.



Advices

1. open windows and doors in the break.
2. go outside of classroom in the break.



Group
Mecha



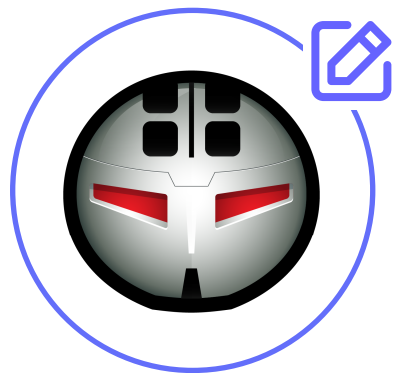
Action



Ranking



Reward



Mecha

Enter the student name or number



Notification

...ss in the morning, the CO2
...in your classroom was higher
than the acceptable level. For your health and
performance, please lower it.

Group members



Helvetica

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Group
Mecha



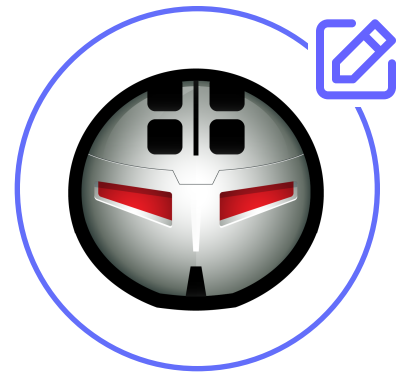
Action



Ranking



Reward



Mecha

Cindy



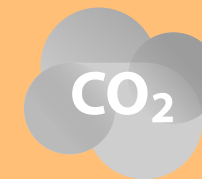
Cindy
Grade 11

Add

Notification

a:

In the math class in the morning, the CO₂ concentration in your classroom was higher than the acceptable level. For your health and performance, please lower it.



The peak CO₂ concentration was 1300 ppm.



Know more about its effect on your health and advices

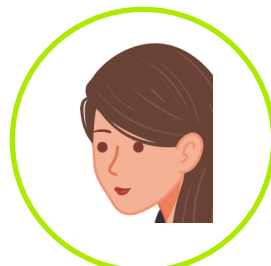


A mail to Paul

Group members



Paul
Grade 12



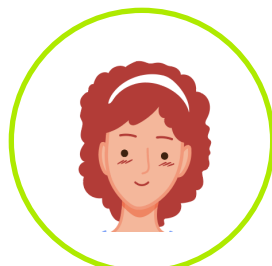
Noëlle
Grade 12



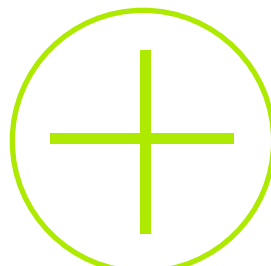
Peter
Grade 12



Lee
Grade 12



Anna
Grade 12





Group
Mecha



Group



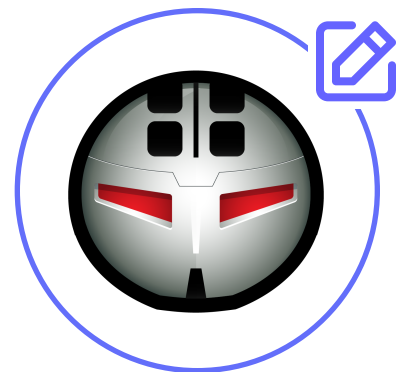
Action



Ranking



Reward



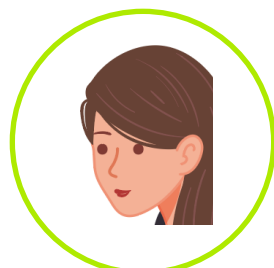
Mecha



Group members



Paul
Grade 12



Noëlle
Grade 12



Peter
Grade 12



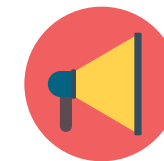
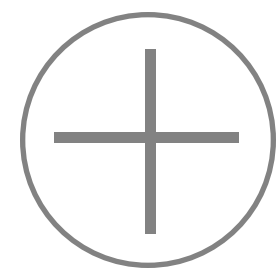
Lee
Grade 12



Anna
Grade 12



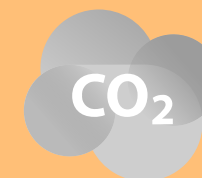
Cindy
Grade 11



Notification

Hey Anna:

In the math class in the morning, the CO₂ concentration in your classroom was higher than the acceptable level. For your health and performance, please lower it.



The peak CO₂ concentration was 1300 ppm.



Know more about its effect on your health and advices



A mail to Paul



Group
Mecha



Group



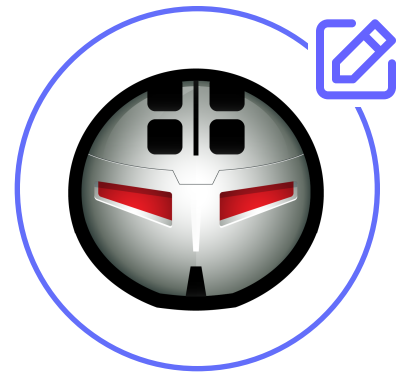
Action



Ranking



Reward



Mecha



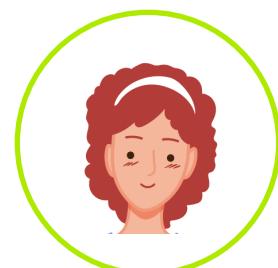
Group members



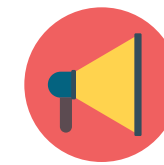
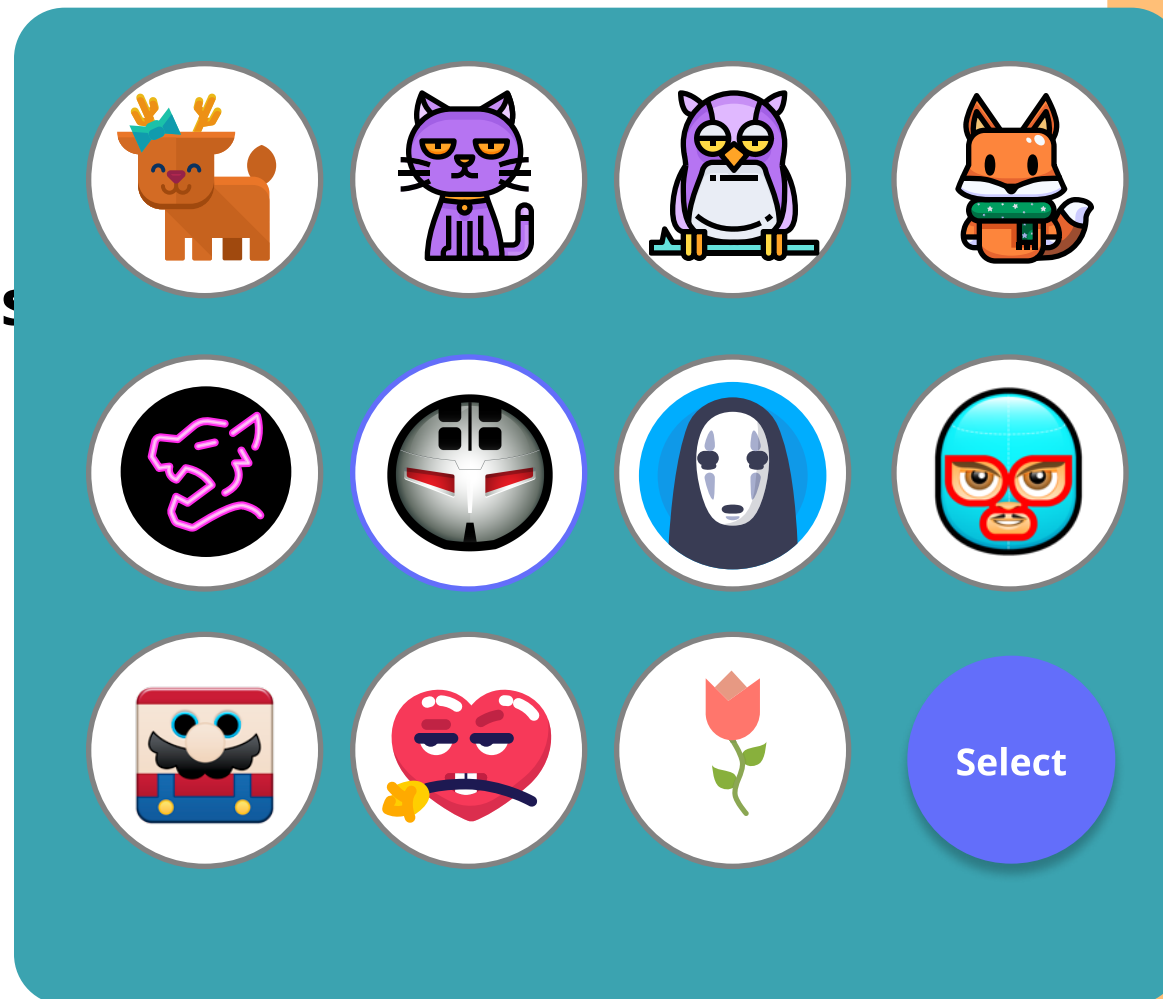
Paul
Grade 12



Peter
Grade 12



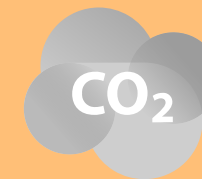
Anna
Grade 12



Notification

Hey Anna:

In the math class in the morning, the CO₂ concentration in your classroom was higher than the acceptable level. For your health and performance, please lower it.



The peak CO₂ concentration was 1300 ppm.



Know more about its effect on your health and advices



A mail to Paul

Appendix 6

Final concept evaluation

The final concept was tested and evaluated with students and teachers. The goal of it is to assess if the design goal and interaction qualities are achieved. The evaluation test was conducted with both a single student and multiple students. Testing with multiple people is to provoke social interactions to simulate a real situation since the concept is based on that. The test will last around 40 mins. At the end of evaluation, participants were asked to fill numerical ranking sheet to assess the interaction qualities and User Experience Questionnaire (UEQ) to assess the usability. If the test is online, participants were asked to share screens while interacting with the intervention. If the test is offline, participants were asked to interact with a tablet.

Test with students

Process:

1. **Introduction:** explain the goal of the test and the context
2. **Testing:** tell participants specific scenarios and ask them to interact with the intervention either individually or within a group. If within a group, ask different participants to interact with the intervention.
3. **Interview:** ask questions related to the experience and the design goal
4. **Survey:** fill numerical rankings for interaction qualities, UEQ for usability. For low years students, the short version of UEQ. For the high years ones, the standard UEQ is provided.

Scenarios:

1. Cindy is also a friend of you and wants to join the group Mecha. And you are happy to welcome her to the group. What would you do?
2. It's a break in the morning now, you want to do some actions to save energy. And your group want to beat others and win the competition. What would you do?
3. It's now lunch time, you just had the lunch with your friends. You want to do actions to keep leading the 1st place in the ranking, what would you do?
4. Today is the end of this month, you are excited to check which group wins in this month. What would you do?
5. Today is the first day of the month after, since your group won the competition, you are invited to attend the ENERGE lunch event in front of students.

Questions asked in the evaluation:

1. How do you feel the design?
2. Does it motivate you to act?
3. What makes you feel motivated?
4. Does it give you confidence to take actions?
5. What makes you feel confident?

(Questions related to group dynamics)

1. Does the group motivate you?
2. Does the group give you confidence?

Analysis:

The feedback from participants was combined and clustered to assess the intervention qualitatively and the surveys were analyzed to assess the interaction qualities and usability quantitatively.

Rank qualities

How much does the design make you feel:

Involved

Feel that it's related
you and the people
and school you care
about



Motivated

Feel that it encourages
you and you want to
do it



Purposeful

Feel that you know
what to do to achieve
the clear goal

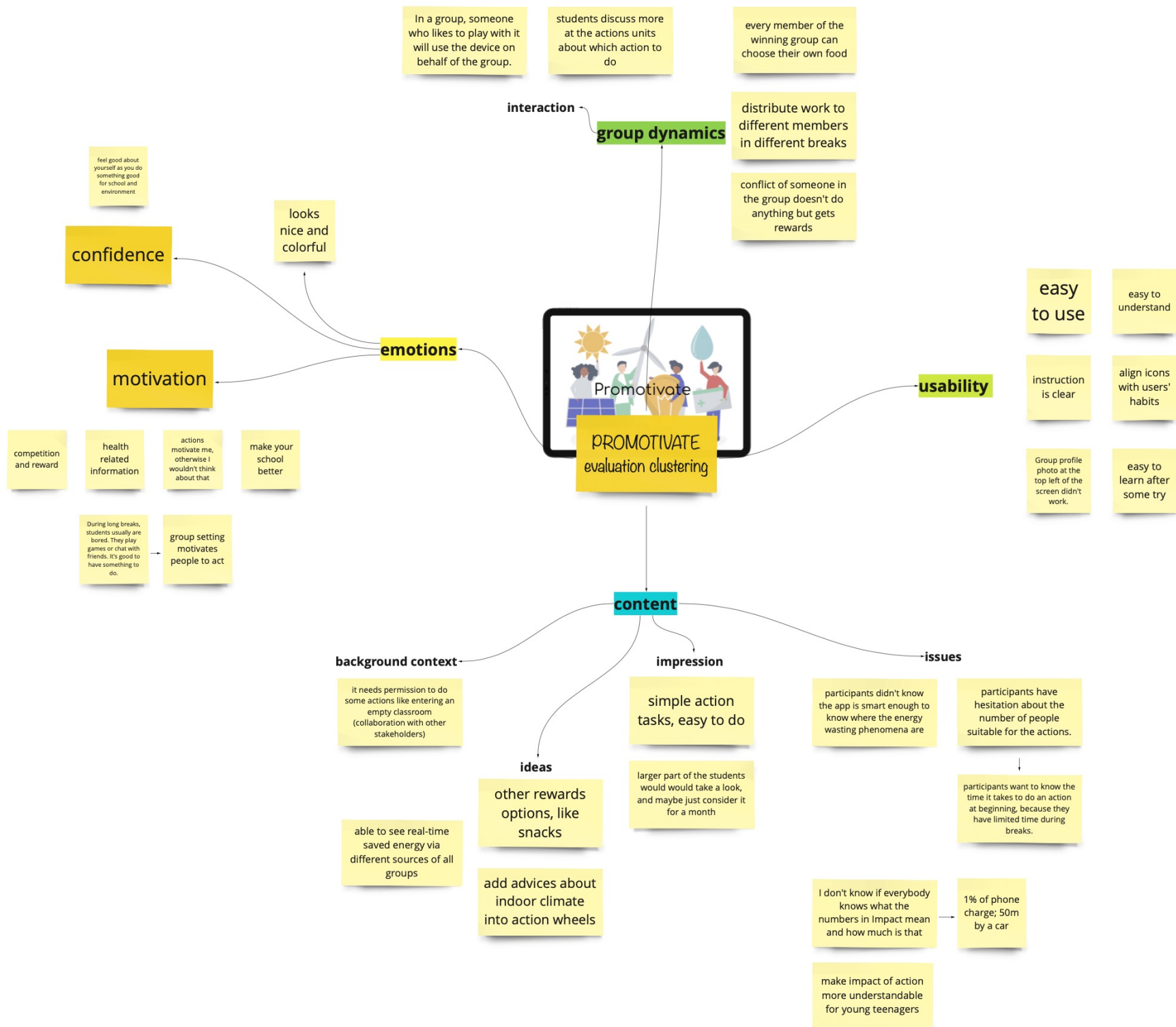


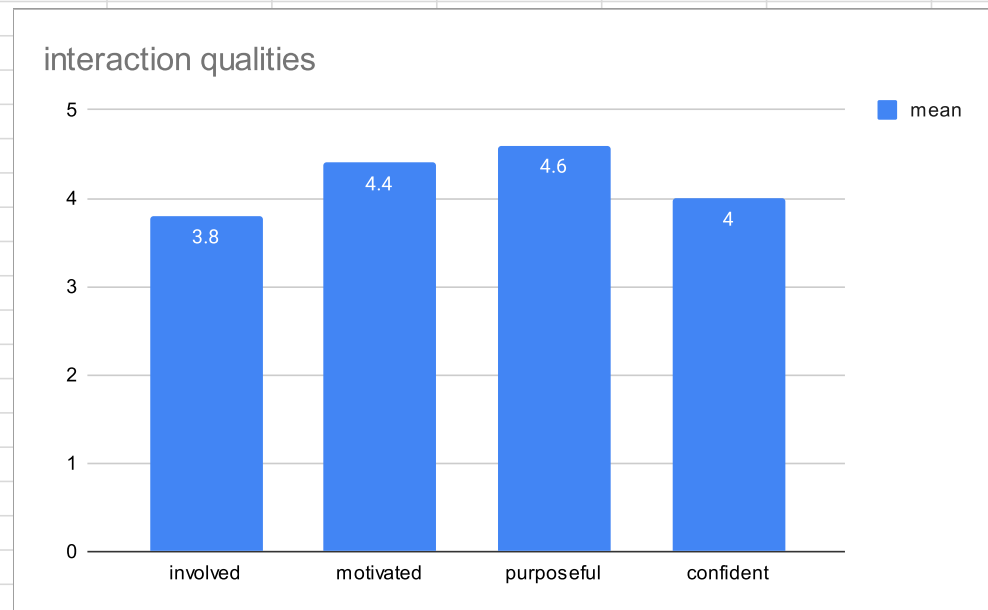
Confident

Feel that you believe
in yourself and you
can do it



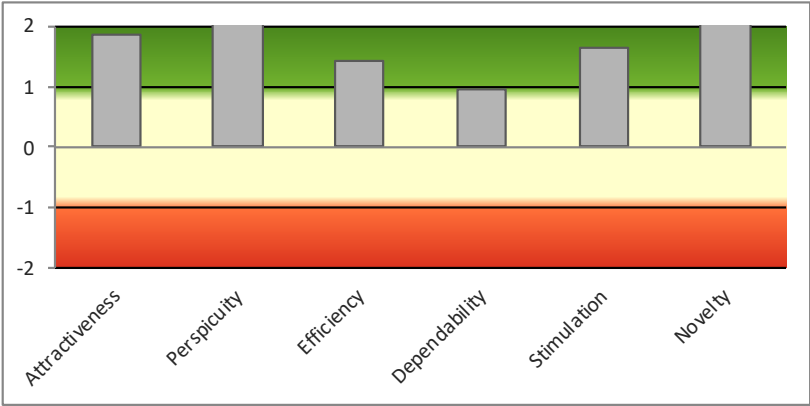
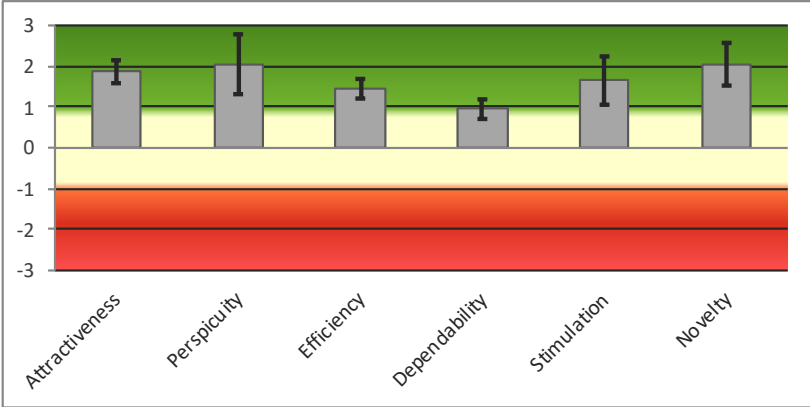
Appendix 7



[illegible]

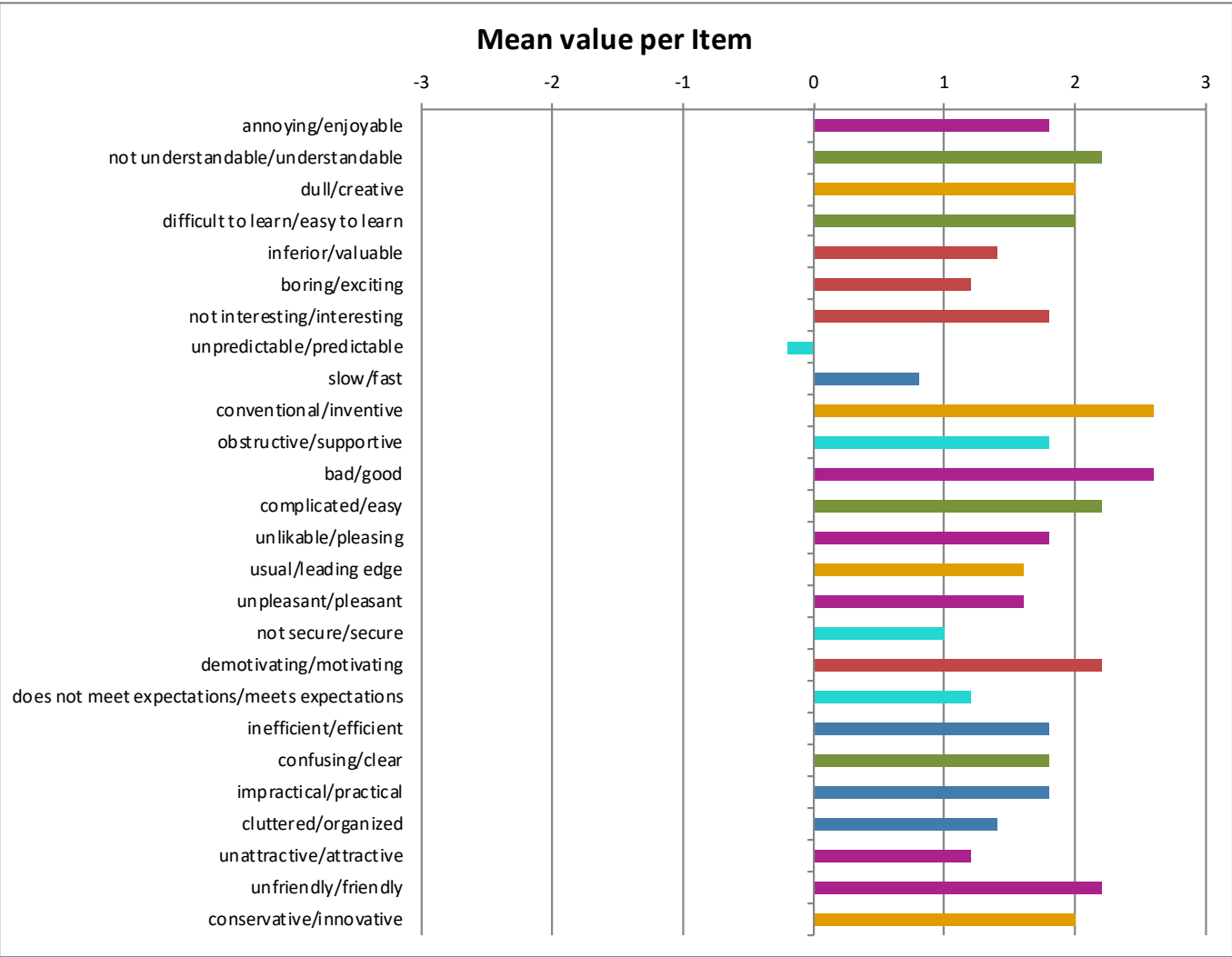
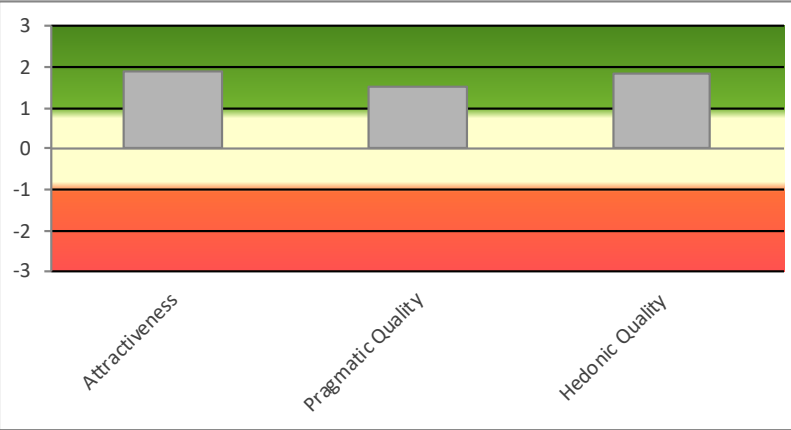
Item	Mean	Variance	Std. Dev.	No.	Left	Right	Scale	
1	↑ 1.8	0.2	0.4	5	annoying	enjoyable	Attractiveness	█
2	↑ 2.2	1.2	1.1	5	not understandable	understandable	Perspiciuity	█
3	↑ 2.0	0.5	0.7	5	creative	dull	Novelty	█
4	↑ 2.0	1.5	1.2	5	easy to learn	difficult to learn	Perspiciuity	█
5	↑ 1.4	0.3	0.5	5	valuable	inferior	Stimulation	█
6	↑ 1.2	1.2	1.1	5	boring	exciting	Stimulation	█
7	↑ 1.8	0.7	0.8	5	not interesting	interesting	Stimulation	█
8	↗ -0.2	1.7	1.3	5	unpredictable	predictable	Dependability	█
9	↑ 0.8	0.7	0.8	5	fast	slow	Efficiency	█
10	↑ 2.6	0.3	0.5	5	inventive	conventional	Novelty	█
11	↑ 1.8	0.7	0.8	5	obstructive	supportive	Dependability	█
12	↑ 2.6	0.8	0.9	5	good	bad	Attractiveness	█
13	↑ 2.2	0.7	0.8	5	complicated	easy	Perspiciuity	█
14	↑ 1.8	0.2	0.4	5	unlikable	pleasing	Attractiveness	█
15	↑ 1.6	2.8	1.7	5	usual	leading edge	Novelty	█
16	↑ 1.6	0.3	0.5	5	unpleasant	pleasant	Attractiveness	█
17	↑ 1.0	1.0	1.0	5	secure	not secure	Dependability	█
18	↑ 2.2	1.2	1.1	5	motivating	demotivating	Stimulation	█
19	↑ 1.2	0.7	0.8	5	meets expectations	does not meet expectations	Dependability	█
20	↑ 1.8	1.2	1.1	5	inefficient	efficient	Efficiency	█
21	↑ 1.8	0.2	0.4	5	clear	confusing	Perspiciuity	█
22	↑ 1.8	0.2	0.4	5	impractical	practical	Efficiency	█
23	↑ 1.4	0.3	0.5	5	organized	cluttered	Efficiency	█
24	↑ 1.2	0.7	0.8	5	attractive	unattractive	Attractiveness	█
25	↑ 2.2	0.7	0.8	5	friendly	unfriendly	Attractiveness	█
26	↑ 2.0	0.5	0.7	5	conservative	innovative	Novelty	█

UEQ Scales (Mean and Variance)		
Attractiveness	↑ 1.867	0.10
Perspiciuity	↑ 2.050	0.70
Efficiency	↑ 1.450	0.08
Dependability	↑ 0.950	0.08
Stimulation	↑ 1.650	0.46
Novelty	↑ 2.050	0.36



Pragmatic and Hedonic Quality	
Attractiveness	1.87
Pragmatic Quality	1.48
Hedonic Quality	1.85

The scales of the UEQ can be grouped into pragmatic quality (Perspiciuity, Efficiency, Dependability) and hedonic quality (Stimulation, Originality). Pragmatic quality describes task related quality aspects, hedonic quality the non-task related quality aspects. Below the mean of the three pragmatic and hedonic quality aspects is calculated.



Scale	Mean	Comparisson to benchmark	Interpretation
Attractiveness	1.87	Excellent	In the range of the 10% best results
Perspicuity	2.05	Excellent	In the range of the 10% best results
Efficiency	1.45	Above Average	25% of results better, 50% of results worse
Dependability	0.95	Below Average	50% of results better, 25% of results worse
Stimulation	1.65	Good	10% of results better, 75% of results worse
Novelty	2.05	Excellent	In the range of the 10% best results

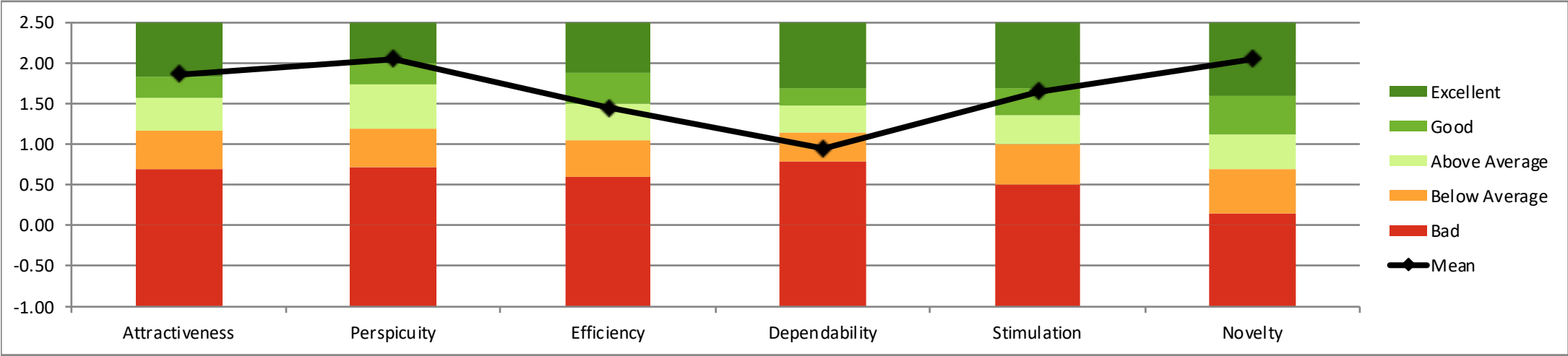


Table to create the benchmark graph (purely technical, please ignore)

Scale	Lower Border	Bad	Below Average	Above Average	Good	Excellent	Mean
Attractiveness	-1.00	0.69	0.49	0.4	0.26	0.66	1.87
Perspicuity	-1.00	0.72	0.48	0.53	0.27	0.5	2.05
Efficiency	-1.00	0.6	0.45	0.45	0.38	0.62	1.45
Dependability	-1.00	0.78	0.36	0.34	0.22	0.8	0.95
Stimulation	-1.00	0.5	0.5	0.35	0.35	0.8	1.65
Novelty	-1.00	0.16	0.54	0.42	0.48	0.9	2.05

Benchmark borders (purely technical, please ignore and do not change)

Scale	25%	50%	75%	90%
Attractiveness	0.69	1.18	1.58	1.84
Perspicuity	0.72	1.2	1.73	2
Efficiency	0.6	1.05	1.5	1.88
Dependability	0.78	1.14	1.48	1.7
Stimulation	0.5	1	1.35	1.7
Novelty	0.16	0.7	1.12	1.6

Appendix 8

Consent for Participation in Interview

For the parents, to seek permission about their child's interview.

I, _____, parent of _____ volunteer to participate in the project conducted by Tao Chen, wherein my child will be interviewed by Industrial Design Engineering students from Delft University of Technology. I give permission to interview my child. I understand that the project is designed to test interface prototypes about using indoor climate data and energy use data to promote sustainable behavior among students in their secondary schools and gather feedback to improve the prototypes.

1. We (my child and I) participate in this project is voluntary. I understand that we will not be paid for the participation. I may choose to withdraw and discontinue participation at any time without penalty. If I decline to participate or withdraw from the study, no one at the Delft University of Technology will be told.

2. I understand that when I feel uncomfortable or my child feels uncomfortable in any way during the session, we have the right to decline to answer any question or to end the interview.

3. I understand that the students will not identify my child or me by name in any reports using information obtained from this session and that my confidentiality as a participant in this study will remain secure.

4. The interview will last approximately 60 minutes. Notes will be taken during the interview by the student present at the session through a Zoom or Teams. A video and thus audio of the interview and dialogue during the session may be recorded. If I do not want my child to be recorded, I will mention this before the interview starts. Furthermore, screenshots from the video can be taken to document this activity.

5. Faculty and administrators from Delft University of Technology will neither be present at the session nor have access to raw notes. This precaution will prevent my individual comments from having any negative repercussions.

6. I understand that this session has been reviewed and approved by the supervisors of the students. For research problems or questions regarding subjects, the chair of the graduation committee may be contacted through the following email address: S.U.Boess@tudelft.nl.

7. I have read and understood the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree and permit my child to participate in this study.

8. I have been given a copy of this consent form.

My Signature

Date

___ Tao Chen _____
Coordinator's Name

Signature of the Coordinator

With any questions, please contact: Tao Chen t.chen-11@student.tudelft.nl

