



CHALMERS
UNIVERSITY OF TECHNOLOGY



Environmental Impact of Food with an Interactive Data Visualization Exhibit

A study of Universeum's visitors' perceptions and experienced learning when using visualization exhibits about sustainable food consumption

Master's thesis in Learning and Leadership

MALOU LIDERFORS & SANDRA LÖVGREN

DEPARTMENT OF COMMUNICATION AND LEARNING IN SCIENCE

CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden 2022

www.chalmers.se

MASTER'S THESIS 2022

Environmental Impact of Food with an Interactive Data Visualization Exhibit

A study of Universeum's visitors' perceptions and experienced learning when using visualization exhibits about sustainable food consumption

MALOU LIDERFORS & SANDRA LÖVGREN



CHALMERS
UNIVERSITY OF TECHNOLOGY

Department of Communication and Learning in Science
Division of Engineering Education Research
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2022

Environmental Impact of Food with an Interactive Data Visualization Exhibit
A study of Universeum's visitors' perceptions and experienced learning when using
visualization exhibits about sustainable food consumption
MALOU LIDERFORS & SANDRA LÖVGREN

© MALOU LIDERFORS & SANDRA LÖVGREN, 2022.

Supervisor: Lena Pareto, department of Education, Communication and Learning,
University of Gothenburg

Examiner: Philip Gerlee, department of Mathematical Sciences, Chalmers Univer-
sity of Technology

Master's Thesis 2022

Department of Communication and Learning in Science

Division of Engineering Education Research

Chalmers University of Technology

SE-412 96 Gothenburg

Telephone +46 31 772 1000

Cover: The exhibition *Vislab* at Universeum, presenting many different interactive
exhibits which the visitors can explore.

Typeset in L^AT_EX

Printed by Chalmers Reproservice

Gothenburg, Sweden 2022

Environmental Impact of Food with an Interactive Data Visualization Exhibit
A study of Universeum's visitors' perceptions and experienced learning when using
visualization exhibits about sustainable food consumption
MALOU LIDERFORS & SANDRA LÖVGREN
Department of Communication and Learning in Science
Chalmers University of Technology

Abstract

The climate is changing, and many commitments must be made to slow down that change. However, many people seem to not know how big the environmental impacts of food are, and what environmentally-friendly food is. At the same time, the visualization of data is becoming a popular tool for educating people. The science center Universeum in Gothenburg has opened a new public visualization exhibition called *Vislab*, focusing on sustainable development and what impact different choices have on our planet. This study is based on a climate-smart visualization exhibit about food consumption at *Vislab*, and aims to investigate the role a visualization exhibit can play in educating the public about different foods' environmental impact.

Many participants believed locally produced food to be environmentally friendly, and seemed to know how to reduce their environmental impact from food consumption but choose not to. 47.1 % of the participants appeared to have problems interpreting the data visualizations, with no significant differences between genders, ages, or educational backgrounds. The males were significantly better at choosing environmentally friendly food than the females were, but no similar differences were found between participants of different ages or educational backgrounds. Most participants seemed to learn about specific food items' environmental impact and 19.6 % commented on how they should change their diet, indicating deeper learning. These findings support the idea of visualization being suitable for educating people regardless of their background about climate change, but it is important to continuously identify and correct eventual deceptive features which can jeopardize the exhibit's purpose.

Keywords: interactive data visualization, visualization exhibit, visitors' interaction, transformative learning, experiential learning, non-learning, field experiment, science center, food consumption, environmental impact, climate.

Acknowledgements

First and foremost, we would like to thank our supervisor Lena Pareto for invaluable help and guidance in planning and performing the study as well as analyzing the results and composing the final report. We could not have done it without her. We would also like to address a big thank you to Universeum for allowing us to execute our study at their exhibition *Vislab*, and for giving free access to the exhibition to all of our pilot study participants. In addition to this, we would like to thank our examiner Philip Gerlee for bringing the opportunity to perform the master's thesis at Universeum to our attention and for helping out whenever we needed it.

Furthermore, we would like to express our gratitude towards our partners Jacob Zachrisson and Victor Grombein for putting up with us when we were particularly stressed out and cranky, and for helping out in any way they could. Last but not least, a big thank you to all of our family and friends for supporting us through this master's thesis, and for some of you even participating in our pilot study.

Malou Liderfors & Sandra Lövgren, Gothenburg, June 2022

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis, listed in alphabetical order:

AC	Abstract Conceptualization abilities
AE	Active Experimentation abilities
CE	Concrete Experience abilities
DVL	Data Visualization Litteracy
TMP	Typical Meal Plate
OMP	Optimal Meal Plate
RO	Reflective Observation abilities
Vislab	The visual laboratory exhibition at Universeum science center in Gothenburg

Contents

List of Acronyms	ix
List of Figures	xiii
List of Tables	xvii
1 Introduction	1
1.1 Background	1
1.1.1 Food consumption and climate change	1
1.1.2 Interactive visualization	2
1.1.3 Vislab at Universeum	3
1.2 Purpose of the study	5
1.3 Limitations	5
1.4 Clarification of research questions	6
2 Theory	7
2.1 Statistical theories	7
2.1.1 Paired t-test	7
2.1.2 Mann-Whitney U test	8
2.1.3 Kruskal-Wallis test	9
2.2 Learning theories	9
2.2.1 Constructivism and Transformative Learning Theory	10
2.2.2 Experiential theory	11
2.2.3 Non-learning	12
3 Methods	15
3.1 Field experiment	15
3.2 Data processing	17
3.2.1 Statistical analysis	18
3.2.2 Thematic analysis	18
3.3 Ethical considerations	20
4 Results	21
4.1 Participants	21
4.2 Meal composition	22
4.2.1 Gender	24
4.2.2 Age	26

4.2.3	Education level	28
4.3	Learning outcomes	30
4.3.1	Observed learning	33
4.3.2	Perceived learning	35
4.3.3	Hypothesis testing for observed and perceived learning	36
4.3.4	Transformative learning	37
4.3.5	Experiential learning	38
4.3.6	Non-learning and mislearning	40
4.3.7	Hypothesis testing for non-learning and mislearning	43
5	Analysis of results and discussion	45
5.1	Results	45
5.1.1	Gender, age, and educational background	45
5.1.2	Common learning outcomes	46
5.1.2.1	Observed and perceived learning	47
5.1.2.2	Learning theories	49
5.2	Method	50
5.3	Exhibit	52
6	Conclusion	53
6.1	Answers to research questions	53
6.2	Future work	54
	Bibliography	55
A	Information to participants	I
B	Environmental budget according to <i>Vislab</i>	III
C	Hypothesis tests	V
D	Transcripts	XI

List of Figures

1.1	The <i>Vislab</i> -exhibition at Universeum, with the exhibit about different foods environmental impact in the foreground.	4
1.2	An example of what it might look like for visitors who have composed their breakfast on the climate-smart exhibit.	5
2.1	The Experiential Learning Cycle (Kolb, 2015, p. 51, Figure 2.5) . . .	12
4.1	Distribution of age for the 51 participants. The number of participants in each group is presented within parentheses in the legend. . .	21
4.2	Finished educational level for the 51 participants. The number of participants in each group is presented within parentheses in the legend.	22
4.3	Bar chart showing the number of participants who chose a specific food item when creating their TMP and OMP.	23
4.4	Table from SPSS with the mean values and standard deviations from the three paired t-tests between the TMP and OMP regarding the environmental aspects. The mean values are percentages of a sustainable daily budget. The green values are the lowest (and best) mean values within each pair.	24
4.5	A table presenting the number of participants within each gender who chose a specific food item when creating their TMP and OMP. Darker blue and green colors indicate more commonly picked food items within that gender group and for that plate. At the bottom of the table, “Participants” stands for the total number of participants within that specific group while “Average” is the average number of picked food items for that group and plate.	25
4.6	A table report from SPSS with the mean value for the group female and male. The values are presented in percentages for the TMP and OMP regarding the environmental aspects. The calculated means are the participants’ estimated consumption in the percentage of their sustainable daily budget within the environmental aspects. Colored cells indicate significant differences across the groups, where pink is used for the lowest value and purple is used for the highest value. . .	26

4.7	A table presenting the number of participants within each age group who chose a specific food item when creating their TMP and OMP. Darker blue and green colors indicate more commonly picked food items within that age group for that plate. At the bottom of the table, “Participants” stands for the total number of participants within that specific group while “Average” is the average number of picked food items for that group and plate.	27
4.8	A table report from SPSS with the mean values for the different age groups. The values are presented for the TMP and OMP regarding the environmental aspects. The calculated means are the participants’ estimated consumption in percentage of their sustainable daily budget within the environmental aspects.	28
4.9	A table presenting the number of participants within each educational level group who chose a specific food item when creating their TMP and OMP. Darker blue and green colors indicate more commonly picked food items within that educational group for that plate. At the bottom of the table, “Participants” stands for the total number of participants within that specific group while “Average” is the average number of picked food items for that group and plate.	29
4.10	A table report from SPSS with the mean values for the groups within each educational level. The values are presented for the TMP and OMP regarding the environmental aspects. The calculated means are the participants’ mean values in percentage of their sustainable daily budget within the environmental aspects. Colored cells indicate significant differences across the groups, where pink is used for the lowest value and purple is used for the highest value.	30
4.11	Venn diagram of the number of participants who had any observed learning, perceived learning and explicitly said that they did not learn anything.	31
4.12	The number of different types of observed learning reflections per participant in percent. The number of participants in each group is presented within parentheses in the legend.	34
4.13	A shading matrix showing the number of intersections between two types of reflections within the theme of observed learning. A darker blue color indicates a larger amount of participants making the combination of the two reflections. The yellow diagonal shows the total amount of participants having each reflection type, where a darker yellow color indicates a more common reflection type.	35
4.14	The number of different types of perceived learning reflections per participant in percent. The number of participants in each group is presented within parentheses in the legend.	36

4.15	A shading matrix showing the number of intersections between two types of reflections within the theme of perceived learning. A darker green color indicates a larger amount of participants making the combination of the two reflections. The yellow diagonal shows the total amount participants having each reflection type, where a darker yellow color indicates a more common reflection type.	36
4.16	The number of participants with non-learning or mislearning behaviour.	41
4.17	The number of participants with non-learning or mislearning behaviour, categorized by gender.	41
4.18	The number of participants with non-learning or mislearning behaviour, categorized by age.	42
A.1	The note all participants were given after participating in the study. .	I

List of Tables

4.1	Number of participants within each educational level and age group who said they did not learn anything but still had either observed or perceived learning, or both.	32
4.2	Examples of each of the seven subgroups within observed and perceived learning.	33
4.3	The observed learning themed into seven different types of reflections. The number of participants in each observed learning theme is presented, followed by the percentage of the total amount of participants in parentheses.	34
4.4	The perceived learning themed into seven different types of reflections. The number of participants in each perceived learning theme is presented, followed by the percentage of the total amount of participants in parentheses.	35
B.1	Measured values for each food item according to the climate-smart exhibit at <i>Vislab</i> . The values for each food item are for consumption of 100 grams, every day for a year.	III
C.1	The hypothesis test summary shows that there are significant differences between the genders' environmental impact from their OMP when looking at the parameters CO ₂ emissions and water use. There are no significant differences between the environmental impacts from the genders' TMP, or when looking at the land use. Asymptotic significance is displayed and a p-value of less than 0.05 is considered significant.	V
C.2	The hypothesis test summary shows that there are no significant differences between the five different age groups' (13-19, 20-29, 30-39, 40-49, and 50+) environmental impact on any of their plates. Asymptotic significance is displayed, a p-value of less than 0.05 is considered significant, and the K-value is adjusted for ties.	VI
C.3	The hypothesis test summary shows that there are significant differences between the educational groups' environmental impact from their TMP when looking at the parameter water use. There are no significant differences when looking at CO ₂ emissions or land use, or when looking at environmental impacts from the educational groups' OMP. Asymptotic significance is displayed, a p-value of less than 0.05 is considered significant, and the K-value is adjusted for ties.	VII

C.4 The hypothesis test summary shows that there are no significant differences between the learning, the non-learning or the mislearning outcomes within the groups of gender. Asymptotic significance is displayed and a p-value of less than 0.05 is considered significant. . . VIII

C.5 The hypothesis test summary shows that there are no significant differences between the learning, non-learning or the mislearning outcome within the groups of age. Asymptotic significance is displayed, a p-value of less than 0.05 is considered significant, and the K-value is adjusted for ties. VIII

C.6 The hypothesis test summary shows that there are no significant differences between the learning, non-learning or the mislearning outcome within the groups of different educational levels. Asymptotic significance is displayed, a p-value of less than 0.05 is considered significant, and the K-value is adjusted for ties. IX

1

Introduction

As the climate change debate gains more and more attention in today's society, an increasing amount of research about how to slow it down emerges. While the transportation sector is commonly blamed for the increasing amount of greenhouse gases in the atmosphere, voices are raised saying that what and how much we eat has a huge impact on climate change as well. But how much does the general public know about the impact food consumption has on climate change, and how can they best learn more so that we can all together manage the global challenge of reducing the amount of greenhouse gases in the atmosphere?

1.1 Background

In this section, previous research on food consumption and interactive visualization tools will be presented. Information about the new Visual laboratory exhibition *Vislab* at Universeum science center in Gothenburg will also be introduced, with a particular focus on their exhibit about climate-smart food.

1.1.1 Food consumption and climate change

All food consumption involves the emission of greenhouse gases, but different foods lead to different amounts of emissions. Hjerpe et al. (2013) advocate for buying climate-certified food products and have put together a weekly food menu with climate-smart food which, if used, would reduce the emission of greenhouse gases from food consumption by 50 %. Fundamental to the menu is a reduction of meat consumption (especially beef), which stands for a large proportion of the emissions. For Sweden to reach the goal of zero net emissions of greenhouse gases in 2050, Hjerpe et al. (2013) say that it is crucial to also reduce the emissions from the agriculture industry, but it can be easier said than done to get people to change their eating habits.

In a study performed by de Boer and Aiking (2022), the participants were asked about what they considered to be a healthy and sustainable diet. They were also given a list from which they were requested to choose one or more factors that they thought had an impact on sustainable food consumption. The alternatives that were thought to matter the most for a healthy and sustainable diet were “eating a variety of different foods, having a balanced diet” and “eating more fruits and vegetables”. “Eating vegetarian or vegan” was rarely considered to be of importance.

In northwestern Europe, a majority of the participants considered themselves to play an important role in sustainable food consumption. This was not as evident in southern and eastern Europe.

Macdiarmid et al. (2016) investigated the general public's perceptions about in particular meat consumption's possible impact on the environment. The study was conducted through focus groups and interviews. The researchers found that many were unaware of the connection between meat consumption and climate change, that personal meat consumption was thought to have a minor role in a global context among the participants, and that many had a negative attitude towards reducing their meat consumption. According to the study, many participants were also skeptical of research showing a relationship between meat consumption and climate change and they had a more positive attitude and thought it to be more important for the environment to change behaviours that were not linked to food consumption.

1.1.2 Interactive visualization

To enhance the general public's knowledge about sustainable food consumption, education is needed. Historically, the retrieval of knowledge has mainly been done through textual, mathematical, and visual literacy but as the society is developing, there is an increasing focus on the importance of data visualization literacy (DVL); the ability to read, interpret and make meaning from visually represented data (Börner et al., 2019). Kirk (2020) says that it is highly necessary to be able to understand visual data representations to participate actively in today's society, and believes that DVL is a shared responsibility between the illustrator and the user; while the illustrator must strive to make the data as understandable as possible, the user must also be motivated and willing to obtain abilities in DVL. DVL has already been needed for quite some time to read and decipher diagrams and graphs, but with today's new digital technology it is also an extremely important ability when learning through interactive visualizations.

In a report from Ynnerman et al. (2018), the concept "explorantion" is described as a combination of exploration and explanation when learning. Ynnerman et al. (2018) means that curiosity-arousing parts of the data need to be presented and explained pedagogically, while the visitors at the same time get to feel that they are in control of what they are watching and exploring. Ynnerman et al. (2018) also states that visualization, in particular, is a very versatile and useful tool and that it is common for interactive visualization tools to become "magnets" where many visitors gather around and watch while a single visitor explores a data set. The report also states that the installation of visualization tools in museums and science centers has led to an increasing amount of visitors. Through explorantion, people can explore different subjects on their own and through that hopefully take the given information to heart more easily.

Ma et al. (2012) has investigated what visitors see and think when visiting an interactive exhibition and describe how many of the visitors asked questions about other

things than what the exhibit was about, which indicates motivation to explore the data further but also underlines the importance of access to background information for enhanced understanding. The same study advocates for a focus on helping the visitors to understand important relationships and key concepts rather than having visualizations that are completely scientific correct in regards to colors, sizes, and similar attributes. Visualization seems to endorse learning but since visits to science centers are based on a personal interest it is important for the visualizations to spark interest already at the first glance, to be meaningful at several different levels of knowledge, and to be easy to understand (Ma et al., 2012).

In a study conducted by Ma et al. (2020) it was investigated how visitors decode visualizations of scientific data, as well as which aspects of the visualization design help or hinder the decoding. The study found that the visitors decode the screens little by little continuously while they interact with the scientific data, instead of decoding the entire screen at once. The visitors did not decode different parts of the visualization systematically; instead, they often went back and revisited previous images to interpret the decoding. Ma et al. (2020) states that this indicates a need among the visitors to support the decoding after their first experience with the visualization. It was also found that external representations, such as animations, graphs, maps, and similar, supported the visitors' ability to decode. Data visualization is getting more and more central in trying to understand our surroundings and can give important insights into critical, scientific topics such as climate change, genomics, and epidemiology (Ma et al., 2020).

1.1.3 Vislab at Universeum

At the beginning of 2022, the science center Universeum in Gothenburg opened a public visualization laboratory called *Vislab* and fundamental for a large proportion of the exhibition is the environment and sustainable development. The aim of the exhibition is for the visitors to gain a stronger and deeper understanding of sustainable development, and what impact different choices we make have on our planet (Universeum, 2022). With *Vislab*, Universeum also gets a chance to better understand the possibilities and limitations of data visualization. Universeum (2022) states that images are the fastest way to understand data since they get past educational and cultural barriers more easily and that they facilitate the understanding of complex relationships. Universeum does, however, wish to gain more information about how their exhibits endorse learning and what visitors could gain from interacting with the exhibition.

In the *Vislab* exhibition there are several interactive exhibits where the visitors can freely click on things that interest them to learn more. Figure 1.1 shows the interactive exhibit this study will focus on (hereafter called “the climate-smart exhibit”) in the foreground, with many of the other exhibits in the exhibition visible in the background. The exhibits deal with many different subjects such as food consumption, ecosystems, infrastructure, anatomy, and space.



Figure 1.1: The *Vislab*-exhibition at Universeum, with the exhibit about different foods environmental impact in the foreground.

At the climate-smart exhibit, the visitors can choose from a variety of foods. For each food product, they can vary the amount and how often the product is being eaten (per day or per week). The exhibit then shows the visitor what yearly environmental impact the food product has in terms of greenhouse gas emissions, land use, and water consumption. The visitors can also collect many different food products on a digital plate and see how big the environmental impact is from all food products put together, see Figure 1.2. To the right in Figure 1.2 there are three icons where the cloud stands for CO₂ emissions, the tree stands for land use and the droplet stands for water consumption. The percentages inform how many percent of a sustainable, daily consumption the plate stands for. Thus, a visitor who eats the breakfast shown in Figure 1.2 uses 47 % of their sustainable daily water consumption budget on their breakfast meal. By pressing the icons, the visitors are presented with exact numbers (kilograms of CO₂ emissions, square meters of land use, and liters of water consumption) instead of percentages. To the left in Figure 1.2, there is a summarized table that shows bars of greenhouse emission (white), land use (light blue), and water use (blue). The bars lengths for the different food items on

the plate are in relation to each other. In the summarized table, the amount of a picked food item can also be seen.

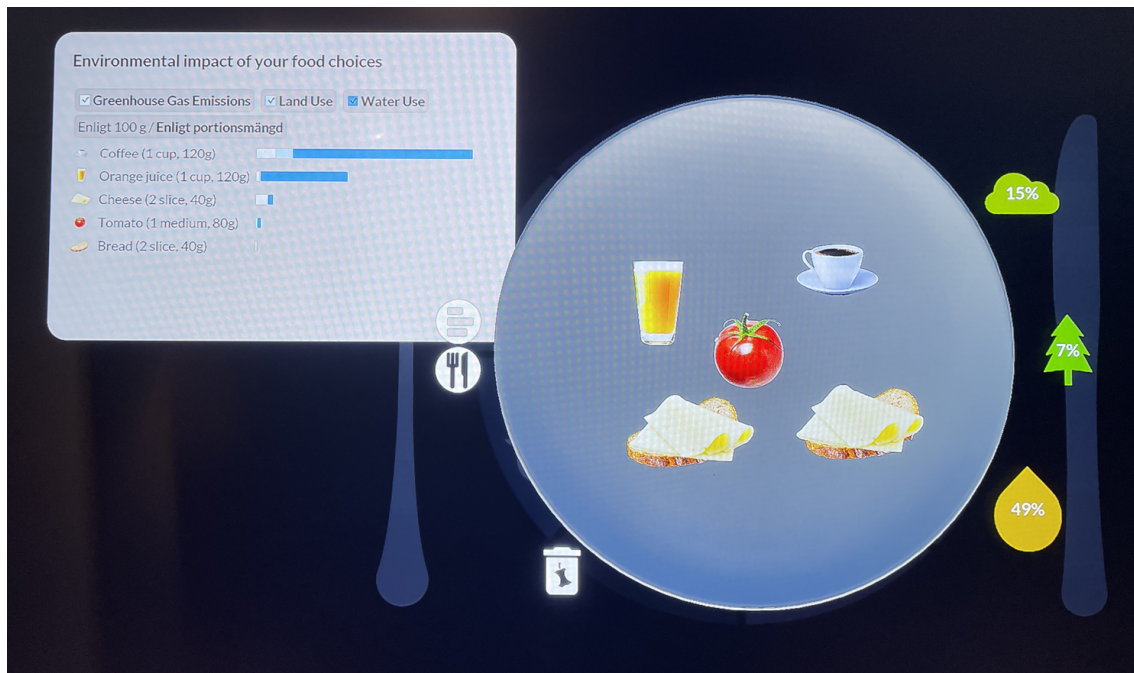


Figure 1.2: An example of what it might look like for visitors who have composed their breakfast on the climate-smart exhibit.

1.2 Purpose of the study

The purpose of this study is overall to investigate the role a science museum can play concerning the public's understanding of the environmental impact of food choices; more specifically to explore what learning the public can gain from a visualization exhibit on meals' environmental impact. Hopefully, this will give a more clear picture of if and in that case how much information and enhanced understanding a citizen can get through visualization exhibits, to gain a better understanding of if interactive visualization exhibits are the right way to go when designing new, pedagogical learning tools.

1.3 Limitations

The climate-smart exhibit shows no information to the visitors regarding nutritional content. Therefore, this study will only focus on the environmental impact of the visitors' plates, without any consideration of the nutritional content of the plates. Thus, it is possible for a visitor to present a plate with very low environmental impact but which does not meet the daily recommended intake of different nutrients advocated by nutritional experts.

The study will not take into consideration what the visitor might eat during the rest of the day, apart from the plate generated during the experiment. The visitor could therefore present a plate with low environmental impact but which also does not keep the visitor satisfied for very long, leading to the visitor eating more during their next meal. A consciously low environmental impact from the first meal could consequently lead to an increase in the total environmental impact from the entire day.

Since *Vislab's* primary target group is visitors aging from 13 years and older, no one under the age of 13 will be a part of the study. Visitors 15 years old or younger will only be allowed to participate if their legal guardians give permission. To more clearly be able to distinguish age, gender, and educational background among the participants, those who want to explore the climate-smart exhibit in pairs or larger groups will not be able to participate in the study.

1.4 Clarification of research questions

In order to achieve the purpose of this study, four primary questions have been formulated:

- How do visitors choose food items for a typical meal for them compared to their idea of an environmentally optimal meal?
- Is the information provided by the climate-smart exhibit clear to the visitors, or are there indications of misinterpretations during the interactions? Were there any differences regarding misinterpretations related to gender, age, or educational background?
- What do the visitors' environmentally optimal plates tell us about their view on climate-smart food consumption? Were there any differences regarding gender, age, or educational level?
- What indications of learning can be revealed/identified during the visitors' interactions with the climate-smart exhibit?

2

Theory

In this chapter, all the theories behind the study will be presented. The theories described are of both mathematical and sociological nature.

2.1 Statistical theories

The study has used multiple different statistical tools. Each statistical method that has been used in the study is described below.

2.1.1 Paired t-test

With pairs of data, i.e. two observations from each sample or individual, a paired t-test can be conducted to investigate whether or not the differences between the sample pairs are statistically significant (Devore, 2016). To do a paired t-test, the samples need to be random and the differences between the pairs need to be approximately normally distributed; however, if the sample size is large enough (over 30), the criteria of normally distributed difference means no longer needs to be fulfilled (Devore, 2016). The hypotheses in the paired t-test are

$$H_0 : \mu_D = 0 \tag{2.1}$$

$$H_A : \mu_D \neq 0 \tag{2.2}$$

where H_0 is the null hypothesis to be tested, H_A is the alternative hypothesis, and μ_D is the expected mean value of the differences between the pairs (Devore, 2016). The test statistic value t can be calculated as

$$t = \frac{\bar{d} - 0}{s_D / \sqrt{n}} \tag{2.3}$$

where \bar{d} is the sample mean of the differences between the pairs, s_D is the sample standard deviation of the differences between the pairs and n is the sample size (Devore, 2016). To use the t -value in a t -curve table, one also needs to calculate the degrees of freedom v as

$$v = n - 1 \tag{2.4}$$

where n is again the sample size (Devore, 2016). From the t -curve table, a p -value (probability value) can be obtained, but since H_A can imply either that μ_D is less

than zero, or that μ_D is larger than zero, the p -value from the t-curve table must be multiplied by two and if the p -value is lower than 0.05, H_0 can be rejected at a confidence level of 95 % (Devore, 2016).

2.1.2 Mann-Whitney U test

The Mann-Whitney U test (sometimes also called the Wilcoxon Rank-Sum test) is a nonparametric test that can be used to examine if the difference in means between two independent, random samples is statistically significant, but where a two-sample t-test cannot be conducted due to the population distributions not being normally distributed (Devore, 2016). The Mann-Whitney U test assumes that both the shape and the spread is the same in the two distribution, and then states the null hypothesis and three alternative hypotheses as

$$H_0 : \mu_1 - \mu_2 = \Delta_0 \tag{2.5}$$

$$H_a : \mu_1 - \mu_2 > \Delta_0 \tag{2.6}$$

$$H_a : \mu_1 - \mu_2 < \Delta_0 \tag{2.7}$$

$$H_a : \mu_1 - \mu_2 \neq \Delta_0 \tag{2.8}$$

where μ_1 is the mean value of the smaller sample, μ_2 is the mean value of the larger sample and Δ_0 is the amount of which the smaller sample is shifted by to the right of the larger sample (Devore, 2016). When performing a Mann-Whitney U test, all observations in both samples together are arranged in order from smallest to largest and then assigned a rank going from 1 (smallest observation) up to the total number of observations of both samples (largest observation) (Devore, 2016). The test statistic value w for the Mann-Whitney U test is then defined as

$$w = \sum_{i=1}^m r_i \tag{2.9}$$

where m is the number of observations in the smaller sample and r_i is the assigned rank for observation i in the smaller sample (Devore, 2016). Depending on the alternative hypothesis, the p -value can be calculated in the following three ways

$$P_0(W \geq w) \tag{2.10}$$

$$P_0(W \leq w) = P_0(W \geq m(m + n + 1) - w) \tag{2.11}$$

$$2P_0(W \geq \max\{w, m(m + n + 1) - 2\}) \tag{2.12}$$

where w is the test statistic value, m is the sample size of the smaller sample and n is the sample size of the larger sample (Devore, 2016). Equation 2.10 should be used together with Equation 2.6, Equation 2.11 should be used together with Equation 2.7, and Equation 2.12 should be used together with Equation 2.8 (Devore, 2016). When $m = 3$ and $n = 4$, the distribution of W is symmetric about the middle value $m(m + n + 1)/2$, giving easily obtained P-values for lower-tailed and two-tailed tests from a tabulation of upper-tailed null distribution probabilities (Devore,

2016). When m and n exceeds 8, a normal approximation can be used for the W distribution (Devore, 2016). Values for $P_0(W \geq w)$ can be obtained from a table and if the p-value is then equal to 0.05 or less, the null hypothesis can be rejected in favor of the alternative hypothesis (Devore, 2016).

2.1.3 Kruskal-Wallis test

The Kruskal-Wallis test is similar to the Mann-Whitney U test in that it is non-parametric and used for comparing independent samples in populations that are not normally distributed, but the Kruskal-Wallis test can be used for more than two samples Devore (2016). The null hypothesis in the Kruskal Wallis test is that the population means of each sample are the same; in other words

$$H_0 : \mu_1 = \mu_2 = \dots = \mu_I \quad (2.13)$$

where I is the number of samples and μ is the mean value of each sample (Devore, 2016). Similar to the Mann-Whitney U test, all observations in the data set are arranged in order from smallest to largest and then ranked from 1 (smallest) to I (largest) (Devore, 2016). The test statistic value K can then be calculated as

$$K = \frac{12}{N(N+1)} \sum_{i=1}^I J_i \left(\bar{R}_i - \frac{N+1}{2} \right)^2 = \frac{12}{N(N+1)} \sum_{i=1}^I \frac{R_i^2}{J_i} - 3(N+1) \quad (2.14)$$

where N is the total number of observations in the data set, I is the number of samples, J_i is the sample size of sample i , R_i is the sum of the ranks for all observations in sample i , and \bar{R}_i is the rank mean value for all observations in sample i (Devore, 2016). The second expression for K in Equation 2.14 is called the computational formula and is easier to use since it only contains one subtraction (Devore, 2016). While there are tables available to find the p-value $P_0(K \geq k)$ for the Kruskal-Wallis test, they are tiresome to use, and instead an approximation for “large samples” can be used; when H_0 is true and there are either three samples where each sample contains no more than six observations, or there are more than three samples where each sample contains no more than five observations, K is approximately chi-squared distributed with $I - 1$ degrees of freedom and so the approximate p-value can be found under the χ_{I-1}^2 -curve to the right of k (Devore, 2016).

2.2 Learning theories

Several different learning theories are used to describe patterns and behaviours from the study. Since the exhibition *Vislab* at Universeum is based on the idea that each visitor will search for and explore the data available in their own way, learning theories that focus on experience and exploration were considered to be best at helping to explain possible learning outcomes from the study. The transformative learning theory can explain how the visitors can transform their already existing beliefs into new ones, while the experiential learning theory helps explaining different stages the visitors move through in their learning process. Learning does, however,

not automatically occur in every learning situation, which can be explained by non-learning theory to better understand underlying causes.

2.2.1 Constructivism and Transformative Learning Theory

Constructivism is based on the idea that knowledge is constructed upon a personal unique pre-knowledge; people learn to learn, motivation is the key to learning and learning is an active, social process that is contextual and engages the mind (Bada and Olusegun, 2015). This means that the learning outcome will be unique for every person who enters a new learning situation and the continued learning will depend on what the person believes to be true (Bada and Olusegun, 2015). Within the theory of constructivism, there are different points of view, such as the classic cognitive constructivism by Jean Piaget who claims that learning is related to cognitive development, and the social constructivism by Lev Vygotsky whose ideas are more focused on societal and peer influence (Schcolnik et al., 2006).

The transformative learning theory is a type of constructivism by Emeritus Professor Jack Mezirow. Transformational learning occurs when the learner's beliefs about topics, issues, or situations are changed (transformed) through critical reflections which challenge the learner's frames of reference (Mezirow, 1997). These frames of reference are shaped by previous conative, cognitive, and emotional experiences and form how we understand the world (Mezirow, 1997). *Habits of mind* and *a point of view* are the two dimensions which Mezirow (1997) use to sort people's beliefs through. The *habits of mind* are broad and describe how humans are acting, thinking, and feeling based on social codes such as political, economic, cultural, or educational while *a point of view* is described as more easily changed than habits of mind and more about specific beliefs regarding groups or individuals (Mezirow, 1997).

The critical reflection on taken-for-granted frames of reference is central for transformative learning and will hopefully generate beliefs that are more justified and opinions that are proven to be more truthful (Mezirow and Associates, 2000). Mezirow (1997) saw transformative learning as four learning processes; *support or expand an already existing point of view*, *establish a new point of view*, *transform a point of view* and *transform our habit of mind*. The latter is considered to be the most difficult one to achieve but can be achieved through several transformations of a point of view within the field. In the 1970s, Mezirow constructed a ten-phase long process that he claimed would result in a change of "our personal frame of reference on self-concepts, goals, and criteria for evaluating change" (Mezirow, 1978, p. 7). The ten phases are

- (1) a disorienting dilemma; (2) self-examination; (3) a critical assessment of sex-role assumptions and a sense of alienation from taken-for-granted social roles and expectations; (4) relating one's discontent to a current public issue; (5) exploring options for new ways of living; (6) building competence and self-confidence in new roles; (7) planning a course of ac-

tion and acquiring knowledge and skills for implementing one's plans; (9) provisional efforts to try new roles; and (10) a reintegration into society on the basis of conditions dictated by the new perspective. (Mezirow, 1978, p. 12)

Later on, some changes were considered, such as the importance of dialogue and what the role of support from others could have in the process (Taylor and Cranton, 2012).

2.2.2 Experiential theory

Experiential theory is the belief that learning is a process rather than a set of possible outcomes; concepts and ideas are not fixed but instead continuously obtained and modified through experience (Kolb, 2015). Knowledge is created through the transformation of experience and since that is an iterative process, it is not seen as something to be achieved or collected (Kolb, 2015). With this mindset, no one can ever completely learn something and the way to gain more knowledge is by gaining more experience. Kolb (2015) also means that humans always enter new knowledge areas with some sort of prior knowledge that affects their perceptions and that teachers are to help evaluate and test these apprehensions to create better understanding. Kolb (2015) states that the basis of learning is the resolution of any conflicts between old and new perspectives and he specifically states that

Learners, if they are to be effective, need four different kinds of abilities - *concrete experience* abilities (CE), *reflective observation* abilities (RO), *abstract conceptualization* abilities (AC), and *active experimentation* (AE) abilities. That is, they must be able to involve themselves fully, openly and without bias in new experiences (CE). They must be able to reflect on and observe their experiences from many perspectives (RO). They must be able to create concepts that integrate their observations into logically sound theories (AC), and they must be able to use these theories to make decisions and solve problems (AE). (Kolb, 2015, p. 41-42)

Kolb (2015) calls the four abilities experiencing (CE), reflecting (RO), thinking (AC), and acting (AE). Together, they construct a so-called learning cycle, see Figure 2.1. Kolb (2015) states that CE and AC are two ways of grasping experience whereas RO and AE are two ways of transforming the experience and that the ideal learning situation involves all four abilities cyclically.

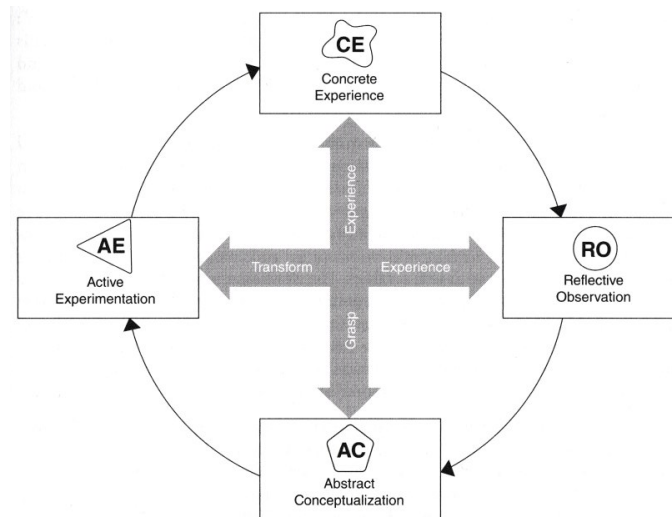


Figure 2.1: The Experiential Learning Cycle (Kolb, 2015, p. 51, Figure 2.5)

2.2.3 Non-learning

Misunderstandings, miscommunication, or just lack of interest in the learning subject are likely reasons for non-learning or mislearning, but in some cases, non-learning is a result of a psychological mechanism called *defense* (Illeris, 2003). According to professor Knud Illeris (2003), defense mechanisms are there for our protection since humans don't want to get overwhelmed by influences they can't sort out or that conflicts with their mental balance. When an influence does not match our general pre-understandings within a specific theme, the influence will be excluded or remade to match the pre-understanding (Illeris, 2003). Another psychological mechanism in the brain that can control what we learn and non-learn is mental *resistance*, which is a natural way of responding to something seemingly impossible to understand or unacceptable to the learner (Illeris, 2003). According to Illeris (2003), it can be difficult in practice to determine if non-learning occurs due to defense mechanisms or due to mental resistance, but it is a clear difference psychologically. To separate the two mechanisms, one has to determine if the non-learning occurred due to the learning situation itself triggering a resistance reaction, or due to pre-understandings triggering a defense mechanism (Illeris, 2003).

A problem with the defense mechanism is that it tends to deepen and fix the pre-understandings within a subject instead of creating new learning, despite the possibility that the pre-understanding is wrong (Illeris, 2003). Moreover, the two psychological mechanisms are essential parts of transformative learning theory and have a strong learning potential if a possible educator can cope with the resistance and defense and manage to turn it into learning (Illeris, 2003). According to Illeris (2003), the possibility of new learning increases once we don't accept something that is presented to us, but real learning occurs only if we also motivate ourselves to seek the truth. With this in mind, non-learning together with both transformative and experiential learning should be able to explain learning patterns among the visitors at *Vislab*. The environment and idea behind *Vislab* seem to benefit the interplay

between the learning theories; if we have a strong (but inaccurate) idea about how things are, we almost need to explore ourselves and find out why our beliefs are wrong to defy the defense mechanism and convince ourselves to re-evaluate our assumptions.

3

Methods

The study was performed by two researchers. The data in this study was collected through a field experiment and then examined by both statistical and thematic analysis. Detailed descriptions of all methods, together with ethical considerations for the study, are presented below.

3.1 Field experiment

The chosen method for this project was a field experiment where data was collected, observations were written down, audio was recorded and a short interview was carried out for each participant. The field experiment was followed by data processing, quantitative statistical analysis, and qualitative text analysis. Experimental methods, such as field experiments, are according to McDermott (2004) the best scientific method for finding out if there are causal links between different phenomena. The same reference claims that other methods can also offer important and convincing arguments for causality, but only experiments can prove it. Field experimental studies are carried out outside the laboratory, often in social environments, and are designed to determine causality between different relationships (Green and Gerber, 2004). According to Green and Gerber (2004), causal patterns can be identified by disrupting the normal flow of the social environment, for example by introducing new information or by creating a different social context. Field experiments are, however, often carried out in environments difficult to control, and the realism that field experiments provide also involves more complexity (Hansen and Tummers, 2020). In addition to this, Hansen and Tummers (2020) also states that it is important to consider whether or not the findings from field experiments apply to larger groups. Since field experiments are suitable for trying to find patterns such as learning patterns, which is what this study aims to do, the method was deemed to be suitable even though it can be difficult to control.

The field experiment was performed during five days at Universeum's exhibition *Vislab*; more specifically at the climate-smart exhibit about the environmental impact of different foods. As many as possible of the visitors who entered the *Vislab* exhibition when the field experiment was carried out were asked to participate in the study. The study strove to gain as large variety as possible among the participants regarding age, gender, and educational background so if many visitors were present, the visitors who seemed to belong to a group which the study did not have as many participants in were primarily asked to participate in the study. However,

no visitors above the age of 13 were excluded from participating (the age requirement is further described in Section 1.3). To achieve the intended scope of 50 or more participants, holidays and weekends were prioritized for the implementation of the field experiment since the number of visitors is much higher on those days.

The field experiment was performed with individual participants led by an experiment leader (one of the researchers) who also recorded the speech of all participants during the experiment on a cell phone. Meanwhile, a documenter (the second researcher) was seated with a computer next to the exhibit. The documenter registered all of the data collection, observations, and interview answers in a digital form. When the experiment started, the participants were first asked by the documenter to fill out a digital form about their gender (“male”, “female”, “non-binary”, “other” or “does not want to state”), age (in numbers) and highest completed educational level (“has not finished lower secondary school”, “lower secondary school”, “upper secondary school (2 years)”, “upper secondary school (3 years)”, “college, university (up to 2 years)” or “college, university (longer education - completed degree)”). After this, the audio recording started and the participants were given time to play around with the climate-smart exhibit to see how it responded to the participants’ actions. Meanwhile, the documenter was noting in the digital form if the participants acknowledged six basic moves on the exhibit which the participants had to know to be able to continue with the upcoming tasks. The six moves were (1) taking a plate, (2) taking a food item, (3) tapping to see what food item it was, (4) deleting a food item, (5) scrolling to find different food items and (6) increasing or decreasing the amount of a picked food item. The try-out time was set to around one minute and if the participants did not explore all six moves during this time, the remaining moves were shown by the experiment leader to make sure that the participants could technically maneuver the upcoming tasks.

The tasks presented by the experiment leader to the participants were to create two different meals on two different plates; one that should correspond to their typical first meal of the day (typical meal plate; TMP) and one that should correspond to their perception of an optimal plate based on environmental impact (optimal meal plate; OMP). The meals were created on the exhibit mentioned above and the participants had no time limit for the composition of any of the plates. The wording “first meal of the day” was chosen instead of “breakfast” since not all people eat breakfast. To ensure that the participants were not affected by the climate footprint result of their OMP, they had to start by creating their TMP. Moreover, the participants were not told that they were going to create an OMP before they had finished creating their TMP. Once the participants had started to create their OMP, they were not allowed to go back to make any changes in their TMP. This procedure was chosen to get as honest TMPs as possible. The documenter documented in the digital form what the participants said and pointed at when creating their plates, as well as which food items the participants ultimately chose for each plate and what environmental impact the exhibit had calculated for each plate. The environmental impact was presented in both percentages and units for CO₂ emissions, land use, and water use (hereafter called “environmental aspects”).

When the participants were done with their OMP, the experiment leader performed a small interview by asking five open-ended questions to the participants. The questions, which were intended to help answer the project’s questions, were “how do you interpret the differences between the plates?”, “was there anything in the result that surprised you?”, “was there anything that felt more or less interesting?”, “have you learned anything and if so, what?” and “if you wanted to know more about this, what kind of information would you look for?”. The documenter registered all answers, both verbal and nonverbal (such as shaking their head, pointing, or other gestures), in the digital form. When all questions were answered, the experiment was considered completed and the audio recording stopped. The participants were given candy as a thank you for their time, together with a note with information about the study and their unique identification number if they would like to withdraw their consent to participate in the study later on.

Before the field experiment, a small pilot study with four participants was conducted to test the method’s structure. The pilot study was carried out in the same way as the field experiment was intended to be carried out, with the exception that the participants in the pilot project were asked to evaluate the survey design and data collection method together with the experiment leader and the documenter after the field experiment was done. After the evaluation of the pilot study, a change from the original plan for the field experiment was made. Before the participants got the tasks to create the two different plates, they were (as explained above) given time to play around with the climate-smart exhibit while the documenter filled in via the digital form if the participant explored the six basic moves on the exhibit. This play-around time was not included in the original plan for the field experiment but seemed to benefit the participants’ ability to perform the tasks later on, instead of spending time managing the user interface interaction moves.

3.2 Data processing

The data from the field experiment was collected in two ways; audio-recorded data and documented text data from the digital form. The audio recorded data was transcribed for all participants and compared with the documented text data from the documenter. This was done to match up all verbal comments (such as “that value was high”) with nonverbal actions (such as pointing at water usage) and to thereby gain a better picture of what the participants had expressed since no video recordings were performed due to ethical considerations (see Section 3.3). The comparison was also made to minimize the impact of errors such as noise disturbing the audio recording, or the documenter not being able to keep up with what the participants said, where hopefully one source of data collection was still working as intended. The summarized textual data resulted in one text file for each participant and contained background information, comments, actions and answers during the experiment, the plates’ content, and the plates’ environmental impact in both percentages and units for the environmental aspects. To be able to better compare results from the participants of different ages, all participants were categorized into the age groups

13-19, 20-29, 30-39, 40-49, and 50+.

3.2.1 Statistical analysis

The statistical analysis is intended to help determine if there are systematic differences in the data, or if the variance could be due to coincidence. If two or more data points are collected from each sample, it is appropriate to perform a paired t-test (Devore, 2016). In a paired t-test, the significance of the difference between pairs of data points for the different samples is examined to know whether it would be possible to say something more general about different groups within the data set (Devore, 2016). As in the case of this study, two different meal compositions were compared for each participant, and each participant is so to speak their own control in comparing the TMP with the OMP. Due to this, the paired t-test is a statistical method giving rather strong results without large populations. If it is statistically certain that there are differences between the paired values, it will mean that people, in general, eat differently from what they think is environmentally friendly. Since the data in this study consist of precisely paired values, paired t-tests were considered to give the most accurate picture of the empirical data.

When comparing samples of non-paired data not normally distributed, common t-tests or linear regression can not be performed (Devore, 2016). Instead, if the data set is non-parametric and considered not to be normally distributed a Mann-Whitney U test (for two samples) or a Kruskal-Wallis test (for more than two samples) can be used to determine if the samples are significantly different from each other (Devore, 2016). Since the sample groups of gender, age and educational background in this study proved not to be normally distributed, Mann-Whitney U tests and Kruskal-Wallis tests were considered to be suitable to perform.

The different plates' environmental impact data for each participant was compiled into the data analysis tool SPSS, where statistical analysis through paired t-tests was performed to examine if there were any significant differences in environmental impact between the TMP and the OMP. Statistical tests of whether or not the differences in environmental aspects between different gender, age, and educational level groups were significant were also carried out by performing either Mann-Whitney U tests or Kruskal-Wallis tests (depending on the sample sizes). SPSS was also used to calculate mean values of the environmental impact from the different population groups (gender, age, educational level). SPSS was also used to perform Mann-Whitney U tests and Kruskal-Wallis tests to see if there were any significant differences in the amount of non-learning behaviour between the different gender, age, and educational level groups.

3.2.2 Thematic analysis

According to Braun and Clarke (2006), thematic analysis can be used to identify and analyze patterns in themes within a data set, which they also consider to be a good way to organize and describe data. Braun and Clarke (2006) describe the

implementation of the thematic text analysis with six steps. The first step is to get familiar with the data and write down some first ideas; in some cases, the text needs to be transcribed and read several times. In the second step, the features of interest in the text which can be observed over the entire data set are systematically coded to be able to compile relevant data for each code. The third step is to identify and create themes in the code. This is followed by step four where the themes are checked with the coded text extracts and what the data set within the theme should contain so that everything is correct. This generates, according to Braun and Clarke (2006), a thematic map illustrating where the theme content comes from. In the fifth step, data is analyzed based on the created themes and theme content and names for each theme are defined. In the sixth and final step, the features which can answer the questions in the study are picked out from the analysis, whereupon they are linked back to previous research to finally be presented in a report. This study aims to analyze the visitors' perceptions and thoughts about environmentally-friendly food, without any preconceptions or ideas from the researchers focusing the analysis in a specific direction, which a thematic analysis was considered to fit well to.

The thematic text analysis was carried out with the summarized textual data, consisting of one text file per participant, in the computer program NVivo. All text files were coded systematically and then compared with each other to make sure that the coding had been performed in the same way for all participants. To do this, the researchers started by coding two participants separately before comparing them with each other to construct a coding schema. Thereafter, one of the researchers started coding the first participant and the other started coding the last participant, eventually "meeting up in the middle". After each day of coding, the researchers' codings were compared with each other to see new coding words and categories invented by any of the researchers. When all participants were coded, the researchers went through the entire material making sure the coding schema was followed everywhere.

Once the coding was completed, the process of finding conceivable themes was done inductively, which means the data is analyzed based on the data itself and not concerning a pre-determined theory (Thomas, 2003). Different codes were put into comprehensive groups which were thought to reflect what the participants considered to be an OMP, as well as what kind of learning outcomes and misconceptions the exhibit could generate. The idea was to generate themes as specific as possible while at the same time including enough participants to be considered a distinct theme. This was an iterative process where themes were created, examined, and then either kept or discarded repeatedly to try and find patterns. Once all codes were organized into a fitting theme, and all themes were considered reasonable, relevant, and useful, the process of identifying and creating themes was considered finished. The themes were then examined one last time to make sure that all codes within the themes were correct and suitable for the respective theme, and that the themes could help answer the research questions.

The result from the thematic text analysis was used when investigating how many participants had shown indications of learning while performing the tasks, as well as

how many participants said themselves that they had learned something. Learning outcomes that particularly high numbers of participants expressed were investigated further. In addition to this, the themes were used for analyzing different types and combinations of learning outcomes to distinguish patterns in learning. The different themes of learning outcomes were examined with statistical analysis to distinguish whether or not there were significant trends in the result between different population groups, i.e. if different population groups showed different amounts of learning outcomes. The quantitative result from the statistical analysis and the qualitative result from the thematic text analysis were compared and compiled to establish conclusions about how different population groups can receive and understand interactive data visualizations about foods' impact on the environment. Furthermore, to explain these learning results, the results were discussed concerning the learning theories about transformative, experiential, and non-learning where several examples from the transcripts were used to illustrate the different learning theories.

3.3 Ethical considerations

The individual information collected about the participants' age, gender, and educational background was not regarded as sensitive information as it could not be used to identify any single individual. Since no names were collected, each test participant's answers were documented under a unique identification number which could not be linked to the visitor afterward. On the assumption that none of the participants were well-known or had a recognizable voice that would make it possible to identify them as individuals, the sound recordings were not regarded as sensitive information and were only used by the researchers to produce the transcripts. The study avoided involving visitors with a well-known and characteristic voice.

Each participant was informed about the purpose of the study. The participants were also given information about how they could interrupt the experiment leader and demand the deletion of all information collected about them at any time during or after the experiment. Furthermore, consent to participate in the study was explicitly requested, and a note with information on how the participant could withdraw their consent was handed out after the experiment was carried out (see Appendix A). For children under 15 years of age, following the Act on Ethical Review of Research about People (2003), consent from all legal guardians of the child was also required. For underage participants, the study was presented as thoroughly as possible to ensure that they fully understood what they agreed on.

The idea of video recording each participant was examined when planning the study. However, since the exhibit was so large the likelihood of accidentally including non-participants in the video, who did not consent to engage in the study, was considered too large. Therefore, a decision was made to both audio record the participants and manually write down observations made, to still gather as much data and information about the participants' comments and actions as possible.

4

Results

In this chapter, the results from the quantitative statistical analysis and the results from the qualitative thematic text analysis will be presented. The results from the participants' meal compositions regarding environmental aspects (CO₂ emissions, land use, and water use) are presented as percentages of a sustainable daily budget according to the climate-smart exhibit at *Vislab*. The data presented for each food item at the climate-smart exhibit at *Vislab* can be found in Appendix B. All statistical tests have been done with a confidence level of 95 %.

4.1 Participants

53 visitors participated in the study. However, during the data processing, two of the participants were deleted from the data collection; one of them was due to a great misunderstanding of the task, and one of them was due to a failure in the audio recording. The collection of 53 participants went down to 51 participants for further analysis. Among the 51 participants, 23 (45.1 %) were males and 28 (54.9 %) were females. None of the participants chose any of the gender options “non-binary”, “other” or “does not want to state”. The data set had a fairly even distribution of age, see Figure 4.1.

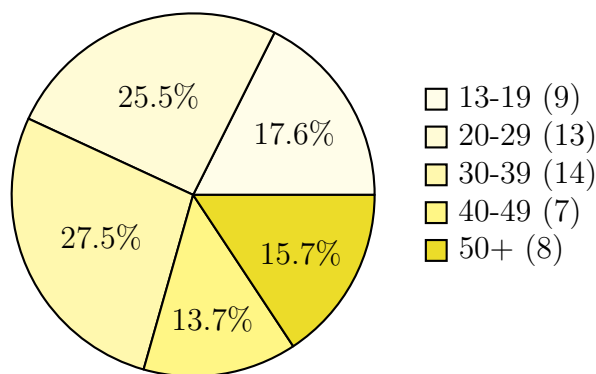


Figure 4.1: Distribution of age for the 51 participants. The number of participants in each group is presented within parentheses in the legend.

There was a slightly distorted distribution within the category of completed educational level, where the majority (58.8 %) of the participants had an educational level of “College, University (longer education - completed degree)”, see Figure 4.2. According to Statistics Sweden (2022), only 29 % of the Swedish population has

an educational level of “College, University (longer education – completed degree)” while in Gothenburg, the proportion is a bit higher (37.87 %). However, it is still not near the study’s rate of 58.8 %. None of the participants had an educational level of “Upper secondary school (2 years)”, why the option “Upper secondary school (3 years)” is hereafter only denoted as “upper secondary school”.

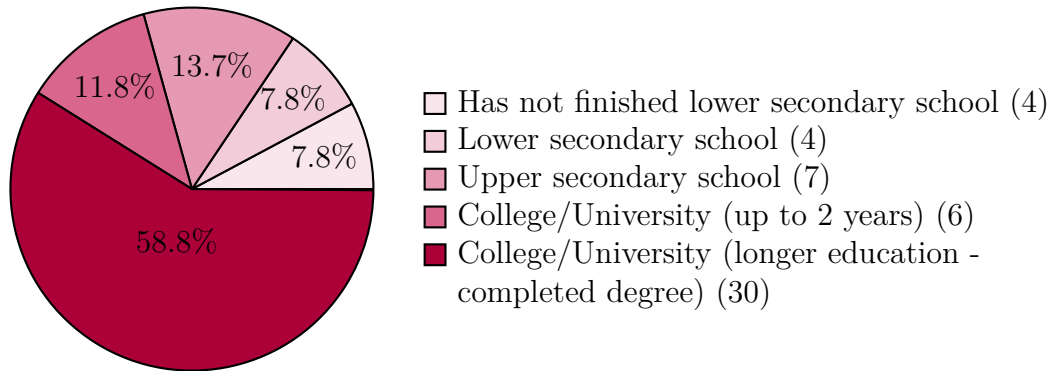


Figure 4.2: Finished educational level for the 51 participants. The number of participants in each group is presented within parentheses in the legend.

4.2 Meal composition

When asked to create the OMP, several questions appeared among the participants such as if they needed to take nutrition, transportation, and/or taste experience into consideration. A common conception among the participants was that the origins of the food mattered for the composition of the OMP. During the study, as many as 23 participants (45.1 %) expressed a belief that locally produced food was better for the environment and many asked if they could see anywhere on the exhibit where the food came from. When asked what they would like to learn more about if anything, 14 participants (27.5 %) answered something associated with locally produced food, such as emissions from transport, what a difference it makes to buy locally produced food or where different foods come from and how much transport that generates.

When the participants created their TMP the most common food item was coffee, followed by bread, oat flakes, cheese, yogurt, egg, and milk in that order. Later on when the participants created their OMP, the most used food item was oat flakes, followed by apple, oat milk, egg, sparkling water, bread, and yoghurt, in that order. In Figure 4.3, a bar chart is shown for the number of participants picking each food item during the TMP and OMP task respectively. When comparing the two plates some differences are visible, such as more participants deciding to put carrot, oat milk, apple, sparkling water, and oat flakes on their OMP compared to their TMP. Moreover, the participants reduced the amount of tomato, juice, banana, ham, milk, yogurt, cheese, bread, and coffee on their OMP compared to their TMP.

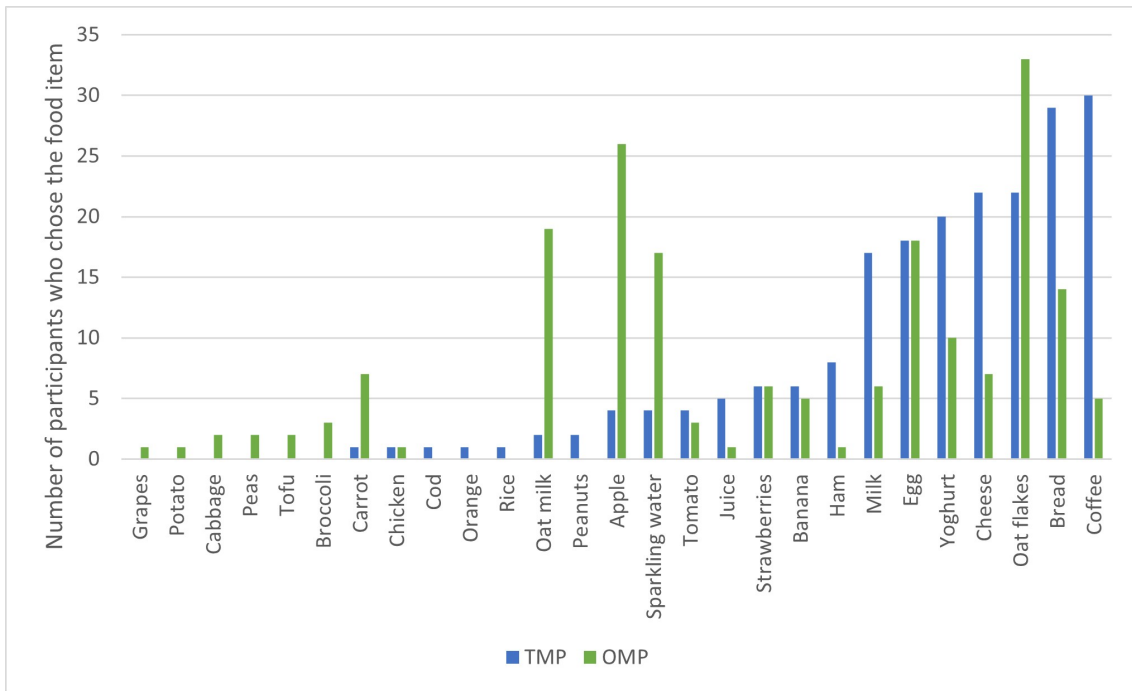


Figure 4.3: Bar chart showing the number of participants who chose a specific food item when creating their TMP and OMP.

Three paired t-tests were performed to evaluate whether there were any significant differences between the plates regarding the environmental aspects (CO₂ emissions, land use and water use). The three null hypotheses were stated as “there are no significant differences in CO₂ emissions/land use/water use between the TMP and the OMP”. The values for each environmental aspect were percentages of a sustainable daily budget. The result from the first paired t-test showed that the TMP ($M = 12.73$, $SD = 6.171$) had higher CO₂ emissions than the OMP ($M = 4.84$, $SD = 3.695$), $t(50) = 9.384$, $p < .001$. When performing the same test in regards of land use, the result showed that the TMP ($M = 5.63$, $SD = 4.094$) had higher land use than the OMP ($M = 1.59$, $SD = 2.051$), $t(50) = 7.419$, $p < .001$. Finally, when looking at the water use, the paired t-test showed that the TMP ($M = 38.45$, $SD = 21.744$) had higher water use than the OMP ($M = 15.92$, $SD = 13.350$) as well, $t(50) = 7.115$, $p < .001$. In other words, all environmental aspects were significantly higher on the TMP than on the OMP and the participants’ OMP can therefore be considered significantly more environmental friendly than their TMP. The mean values and standard deviations for each TMP/OMP and environmental aspect are visualized in Figure 4.4, where the green color indicates the lowest mean value within each pair.

4. Results

		Mean	Std. Deviation
Pair 1	TMP: CO2 emissions (%)	12,73	6,171
	OMP: CO2 emissions (%)	4,84	3,695
Pair 2	TMP: Land use (%)	5,63	4,094
	OMP: Land use (%)	1,59	2,051
Pair 3	TMP: Water use (%)	38,45	21,744
	OMP: Water use (%)	15,92	13,350

Figure 4.4: Table from SPSS with the mean values and standard deviations from the three paired t-tests between the TMP and OMP regarding the environmental aspects. The mean values are percentages of a sustainable daily budget. The green values are the lowest (and best) mean values within each pair.

To look for interesting trends and tendencies within the data set, it was investigated what kind of food items participants of different genders, ages, and educational levels preferred for their OMP. It was also investigated whether or not some population groups had a significantly better OMP regarding the environmental aspects.

4.2.1 Gender

The amount of participants from each gender who picked a specific food item for each plate is presented in Figure 4.5, where a darker blue or green color indicates a more commonly picked item within that gender and for the specified plate. For the females, coffee was the most popular food item to pick for their TMP, followed by oat flakes, yoghurt, bread, cheese, and milk. The males preferred bread, followed by cheese, coffee, and egg for their TMP. When creating their OMP, apple was the most popular food item for females to pick, followed by oat flakes, egg, oat milk, and bread. The males mostly picked oat flakes, followed by sparkling water, oat milk, and apple for their OMP. For both genders, coffee, cheese, and milk were common products to exclude when going from the TMP to the OMP.

The females picked on average a larger number of food products on both the TMP and the OMP than the males did. Both genders picked fewer food items for their OMP than they did for their TMP.

Food item	TMP		OMP	
	Male	Female	Male	Female
Apple	0	4	8	18
Banana	2	4	3	2
Bread	14	15	4	10
Broccoli	0	0	3	0
Cabbage	0	0	0	2
Carrot	0	1	3	4
Cheese	11	11	1	6
Chicken	1	0	1	0
Cod	1	0	0	0
Coffee	11	19	1	4
Egg	9	9	4	14
Grapes	0	0	0	1
Ham	5	3	0	1
Juice	3	2	0	1
Milk	6	11	1	5
Oat flakes	7	15	16	17
Oat milk	0	2	9	10
Orange	0	1	0	0
Peanuts	1	1	0	0
Peas	0	0	0	2
Potato	0	0	1	0
Rice	1	0	0	0
Sparkling water	3	1	11	6
Strawberries	2	4	3	3
Tofu	0	0	2	0
Tomato	0	4	1	2
Yoghurt	5	15	2	8
Participants	23	28	23	28
Average	3,57	4,36	3,22	4,14

Figure 4.5: A table presenting the number of participants within each gender who chose a specific food item when creating their TMP and OMP. Darker blue and green colors indicate more commonly picked food items within that gender group and for that plate. At the bottom of the table, “Participants” stands for the total number of participants within that specific group while “Average” is the average number of picked food items for that group and plate.

Since the sample size was only two for the genders (male or female), Mann-Whitney U tests were performed to investigate whether or not there were any significant differences in environmental impacts between the genders regarding the environmental aspects (CO₂ emissions, land use, and water use). For each plate (TMP and OMP), it was investigated whether or not the distribution of each environmental aspect was the same across both genders. This resulted in six tests with the null hypotheses that there were no differences between the two genders’ environmental impact from their plates. The values for each environmental aspect were percentages of a sustainable daily budget. It was found that there were significant differences on the OMP between the two genders in regards of both CO₂ emissions ($w = 198.5$, $p = .019$) and water use ($w = 159.5$, $p = .002$). However, there were no significant differences between the two genders’ TMP, or between their land uses (see Appendix C for a hypothesis test summary table).

In Figure 4.6, an SPSS report of the mean values of the percentages for the environmental impacts from the TMP and OMP regarding the environmental aspects for males and females is presented. Only the columns where significant differences were detected between the genders are color-coded, where pink indicates the lowest

4. Results

value and purple indicates the highest value. The environmental impacts from the TMP for the male and female participants were quite similar. On average, females use 20.61 % of their daily water budget on their OMP breakfast, whereas males only use 10.22 % of their daily water budget on their OMP breakfast.

Mean						
Gender	TMP: CO2 emissions (%)	TMP: Land use (%)	TMP: Water use (%)	OMP: CO2 emissions (%)	OMP: Land use (%)	OMP: Water use (%)
Female	12,32	5,64	40,57	5,86	1,96	20,61
Male	13,22	5,61	35,87	3,61	1,13	10,22

Figure 4.6: A table report from SPSS with the mean value for the group female and male. The values are presented in percentages for the TMP and OMP regarding the environmental aspects. The calculated means are the participants' estimated consumption in the percentage of their sustainable daily budget within the environmental aspects. Colored cells indicate significant differences across the groups, where pink is used for the lowest value and purple is used for the highest value.

4.2.2 Age

A table showing which food items were selected by the participants in the TMP and the OMP, divided into age groups, is visualized in Figure 4.7. A darker blue and green color indicates a more commonly picked food item for that plate and age group. When looking at the different age groups, it was found that participants of all ages thought that oat flakes are good to pick for their OMP. Many participants had also already picked oat flakes for their TMP. Other common food items on the participants' TMP were coffee, bread, cheese, yoghurt, egg, and milk. In addition to oat flakes, it seems like apple, oat milk, egg, and sparkling water were also considered environmentally friendly and put on the OMP across all different ages. It looks like coffee was the most common food item to exclude from the TMP to the OMP.

The average amount of picked food items on both the TMP and the OMP varied a lot between the age groups. While the age group 20-29 has the lowest average amount of picked food items on both the TMP (1.85) and OMP (1.92), the age group 40-49 has instead the highest amount of picked food items on both the TMP (7.86) and OMP (6.71). The groups 30-39, 40-49, and 50+ picked fewer food items on their OMP than their TMP, while the groups 13-19 and 20-29 instead had a higher average amount of picked food items on their OMP than they did on their TMP.

Food item	TMP					OMP				
	13-19	20-29	30-39	40-49	50+	13-19	20-29	30-39	40-49	50+
Apple	1	0	1	1	1	3	3	8	6	6
Banana	0	2	2	0	2	2	1	2	0	0
Bread	8	3	6	7	5	2	0	5	4	3
Broccoli	0	0	0	0	0	0	2	0	1	0
Cabbage	0	0	0	0	0	0	0	2	0	0
Carrot	0	0	0	1	0	1	0	2	2	2
Cheese	5	3	4	5	5	0	0	3	2	2
Chicken	0	1	0	0	0	0	1	0	0	0
Cod	0	0	1	0	0	0	0	0	0	0
Coffee	2	3	11	8	6	0	1	1	0	3
Egg	3	3	4	4	4	2	3	3	6	4
Grapes	0	0	0	0	0	1	0	0	0	0
Ham	2	0	0	4	2	0	0	1	0	0
Juice	0	0	0	5	0	0	0	0	1	0
Milk	5	1	4	5	2	0	0	2	1	3
Oat flakes	1	2	6	6	7	7	3	7	9	7
Oat milk	0	0	2	0	0	3	2	6	6	2
Orange	0	0	0	1	0	0	0	0	0	0
Peanuts	0	0	1	1	0	0	0	0	0	0
Peas	0	0	0	0	0	1	0	1	0	0
Potato	0	0	0	0	0	0	1	0	0	0
Rice	0	1	0	0	0	0	0	0	0	0
Sparkling water	1	2	1	0	0	4	3	3	4	3
Strawberries	0	1	4	1	0	2	2	0	1	1
Tofu	0	0	0	0	0	0	2	0	0	0
Tomato	0	0	1	1	2	0	0	1	2	0
Yoghurt	1	2	6	5	6	4	1	2	2	1
Participants	9	13	14	7	8	9	13	14	7	8
Average	3,22	1,85	3,86	7,86	5,25	3,56	1,92	3,50	6,71	4,63

Figure 4.7: A table presenting the number of participants within each age group who chose a specific food item when creating their TMP and OMP. Darker blue and green colors indicate more commonly picked food items within that age group for that plate. At the bottom of the table, “Participants” stands for the total number of participants within that specific group while “Average” is the average number of picked food items for that group and plate.

When analyzing the impact of the different environmental aspects from the different age groups, the Kruskal-Wallis test was used since there were five groups to compare. Six tests were conducted on the combinations of TMP/OMP and the three environmental aspects, where the null hypotheses were that there were no differences in CO₂ emissions/land use/water use on the TMP/OMP between the age groups. The values for each environmental aspect were percentages of a sustainable daily budget. The results from the Kruskal-Wallis tests failed to reject any of the null hypotheses, why no conclusions can be drawn about any differences in environmental impact between different age groups (see Appendix C for a hypothesis test summary table). In Figure 4.8, an SPSS report of the mean values of the percentages for the environmental impacts from the TMP and OMP regarding the environmental aspects for the different age groups is presented. Since no differences were significant, no columns are color-coded for highest and lowest values.

4. Results

Mean	TMP: CO2 emissions (%)	TMP: Land use (%)	TMP: Water use (%)	OMP: CO2 emissions (%)	OMP: Land use (%)	OMP: Water use (%)
13-19	11,38	3,63	25,63	4,88	1,38	18,75
20-29	10,86	4,14	27,14	5,29	2,43	16,00
30-39	12,79	6,00	43,36	4,36	1,14	14,21
40-49	13,31	6,38	44,77	3,62	,85	11,38
50+	14,44	6,89	41,89	7,00	2,89	22,56

Figure 4.8: A table report from SPSS with the mean values for the different age groups. The values are presented for the TMP and OMP regarding the environmental aspects. The calculated means are the participants' estimated consumption in percentage of their sustainable daily budget within the environmental aspects.

4.2.3 Education level

Figure 4.9 illustrates the number of participants within each educational level group who picked each food item for each plate, where a darker blue and green color indicates a more commonly picked item within that educational level group and for that plate. When looking at different levels of educational background, oat flakes are often picked for the OMP by all participants across different completed educational levels. For the TMP, bread, cheese, egg, and milk were common to pick across all educational levels. Among the three higher educational levels, coffee was also a common pick for the TMP. Similar to the age groups, coffee was also a common food item to exclude when moving from the TMP to the OMP. The choice of food items for the OMP seems rather widespread among different educational groups, but it may look like the food items apple, oat milk, egg, and sparkling water are more commonly picked among most groups, just like they were when looking at different age groups.

The average amount of picked food items is relatively even across the educational level groups for their TMP and OMP, compared to the differences between the age groups. The groups "Lower secondary school" and "Upper secondary school" picked more food items for their OMP than they did for their TMP, while the rest of the educational level groups picked more food items for their TMP than they did for their OMP.

Food item	TMP					OMP				
	Has not finished lower secondary school	Lower secondary school	Upper secondary school	College, University (up to 2 years)	College, University (longer education - comp. deg.)	Has not finished lower secondary school	Lower secondary school	Upper secondary school	College, University (up to 2 years)	College, University (longer education - comp. deg.)
Apple	0	1	0	0	3	2	1	2	3	18
Banana	0	0	1	0	5	0	2	1	0	2
Bread	4	4	4	1	16	2	0	1	1	10
Broccoli	0	0	0	0	0	0	0	2	0	1
Cabbage	0	0	0	0	0	0	0	2	0	0
Carrot	0	0	0	0	1	0	1	2	0	4
Cheese	2	3	4	1	12	0	0	1	0	6
Chicken	0	0	1	0	0	0	0	1	0	0
Cod	0	0	0	0	1	0	0	0	0	0
Coffee	1	1	4	6	18	0	0	1	1	3
Egg	3	0	3	3	9	1	1	4	2	10
Grapes	0	0	0	0	0	0	1	0	0	0
Ham	1	1	1	0	5	0	0	0	0	1
Juice	0	0	1	1	3	0	0	0	0	1
Milk	3	2	1	3	8	0	0	0	1	5
Oat flakes	1	0	1	3	17	3	4	4	6	16
Oat milk	0	0	0	0	2	2	1	1	4	11
Orange	0	0	0	0	1	0	0	0	0	0
Peanuts	0	0	0	0	2	0	0	0	0	0
Peas	0	0	0	0	0	1	0	1	0	0
Potato	0	0	0	0	0	0	0	1	0	0
Rice	0	0	1	0	0	0	0	0	0	0
Sparkling water	0	1	2	0	1	2	2	6	3	4
Strawberries	0	0	1	2	3	0	2	1	1	2
Tofu	0	0	0	0	0	0	0	1	0	1
Tomato	0	0	1	0	3	0	0	1	1	1
Yoghurt	0	1	2	4	13	1	3	2	0	4
Participants	4	4	7	6	30	4	4	7	6	30
Average	3,75	3,50	4,00	4,00	4,10	3,50	4,50	5,00	3,83	3,33

Figure 4.9: A table presenting the number of participants within each educational level group who chose a specific food item when creating their TMP and OMP. Darker blue and green colors indicate more commonly picked food items within that educational group for that plate. At the bottom of the table, “Participants” stands for the total number of participants within that specific group while “Average” is the average number of picked food items for that group and plate.

When analyzing if there were any differences in environmental impact between the different educational level groups, the Kruskal-Wallis test was used due to the sample size being five. Six tests were conducted on the combinations of TMP/OMP and the environmental aspects, where the null hypotheses were that there were no differences between the educational groups’ impact on the environmental aspects from their plates. The values for each environmental aspect were percentages of a sustainable daily budget. The result from the Kruskal-Wallis tests showed that there were significant differences between the TMPs for the different educational levels when looking at the impact of water use ($K = 9.598$, $p = .048$). There were no significant differences between the OMPs for the different educational levels, or on their impact on CO₂ emissions or land use (see Appendix C for hypothesis test summary table).

In Figure 4.10, an SPSS report of the mean values of the percentages for the environmental impacts from the TMP and OMP regarding the environmental aspects for different groups of educational level is presented. Only the columns where sig-

4. Results

nificant differences have been detected are color-coded, where pink is used for the lowest mean value and purple is used for the highest mean value. The report shows that the educational group “College, University (up to 2 years)” stands out from the others. Their mean value for water use consumption for their TMP is high (63.83 %); so high that a person would exceed their sustainable daily budget if they were eating it twice per day.

Mean						
Highest completed level of education	TMP: CO2 emissions (%)	TMP: Land use (%)	TMP: Water use (%)	OMP: CO2 emissions (%)	OMP: Land use (%)	OMP: Water use (%)
Has not finished lower secondary school	12,00	4,25	30,50	4,25	1,50	19,00
Lower secondary school	10,75	3,00	20,75	5,50	1,25	18,50
Upper secondary school (3 years)	12,43	5,14	33,29	7,00	2,57	17,71
College, University (up to 2 years)	17,50	9,33	63,83	4,50	1,83	17,67
College, University (longer education - completed degree)	12,20	5,53	38,00	4,40	1,37	14,40

Figure 4.10: A table report from SPSS with the mean values for the groups within each educational level. The values are presented for the TMP and OMP regarding the environmental aspects. The calculated means are the participants’ mean values in percentage of their sustainable daily budget within the environmental aspects. Colored cells indicate significant differences across the groups, where pink is used for the lowest value and purple is used for the highest value.

4.3 Learning outcomes

A majority of the participants put coffee on their TMP (30 participants; 58.8 %). On the OMP, however, only 5 participants (9.8 %) added coffee. As many as 22 of the participants (43.1 %), who all had coffee on their TMP, stated that coffee was bad for the environment, either when creating the plates or when analyzing their plates (or both). It was mostly said as an answer to the question if anything surprised them. While 19.6 % of the study’s participants stated that they should change what they eat, not many explicitly said that they should reduce or exclude coffee from their breakfast. One participant even said that “coffee is a villain in environmental impact when grown, but I don’t know when I will quit drinking that”. There was a general resistance to changing their coffee habits. This resistance towards change was not as strong among other products, such as changing milk to oat milk or reducing the amount of meat.

Another common learning outcome for the participants was regarding water use; 16 out of the 51 participants (31.4 %) made some comment about high water usage on one or both of their plates, or a specific product. Many participants stated that they’ve never thought about water usage before when thinking about environmental impact and that they found it interesting and/or surprising to see how much it affected the environment. Several of them hadn’t thought of it as a problem and believed that it wasn’t as relevant for foods grown in Sweden, where access to water is taken for granted. However, only four participants (7.8 %) later said that they

would like to look for more information about water usage if anything.

10 out of the 51 participants expressed a belief that animal products are bad for the environment. However, only five out of those ten made a completely vegan OMP. In addition to this, other common expressions among the participants were that meat is environmentally bad, dairy products are environmentally bad and fruits and vegetables are environmentally good. Ten participants stated that oat milk seems to be bad for the environment.

Possible learning outcomes from the study were divided into two subgroups; observed learning and perceived learning. Observed learning was defined as learning outcomes that the participants may not think of as something they explicitly learned, but still expressed when interpreting the data. Perceived learning was defined as learning outcomes the participants clearly expressed themselves when asked if they found anything particularly interesting or surprising. 49 out of the 51 participants (96 %) had at least one observed learning, whereas 44 (86.3 %) had at least one perceived learning. When asked directly if the participant felt that they learned something by doing the exercise, 11 of the 51 participants (21.6 %) answered that they did not learn anything. However, 10 out of these 11 participants had at least one observed learning outcome and 5 had previously stated that there was something they found interesting or surprising. Only 1 out of the 11 participants who didn't feel that they learned anything had no observed learning and no perceived learning. This data is visualized in a Venn diagram, see Figure 4.11.

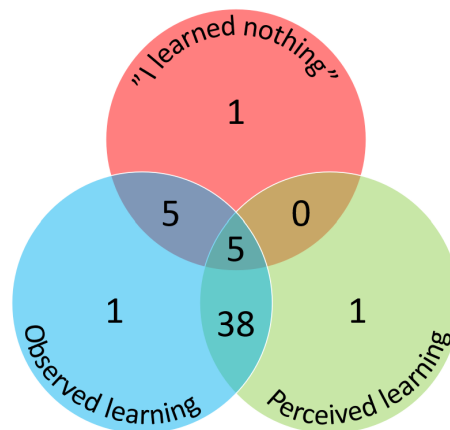


Figure 4.11: Venn diagram of the number of participants who had any observed learning, perceived learning and explicitly said that they did not learn anything.

Among the ten participants who said they did not learn anything while this study indicates the opposite, 50 % were males and 50 % were females. As for the educational level group, the majority of the ten participants belonged to the educational level "College, University (longer education - completed degree)". When looking at the different ages, six out of the ten participants were in the age span 40-49. The percentages of each educational level and age group are presented in Table 4.1.

Table 4.1: Number of participants within each educational level and age group who said they did not learn anything but still had either observed or perceived learning, or both.

Educational level group	Participants	Age group	Participants
“Has not finished lower secondary school”	1 of 4	13-19	1 of 9
“Lower secondary school”	0 of 4	20-29	1 of 13
“Upper secondary school”	2 of 7	30-39	3 of 14
“College, University (up to 2 years)”	1 of 6	40-49	4 of 7
“College, University (longer education - completed degree)”	6 of 30	50+	1 of 8

Both the observed and the perceived learning was categorized into seven subgroups; general reflections, reflections between products, reflections on eating behaviour, reflections on learning, reflections on the measured dimensions, reflections on plates, and reflections on products. These subgroups were developed inductively by looking at the different codes and trying to find patterns and similarities which could be categorized together. The resulting seven subgroups were large enough to include a sufficient amount of participants, while still being able to say something more specific about similarities and differences.

General reflections are all reflections that showed some kind of learning but didn't fit into any of the other subgroups. Reflections between products are when the participant has made comparisons between different foods. Reflections on eating behaviour are reflections where the participant has made comments on their eating behaviour in relation to the information presented in the exhibit. Reflections on learning are occasions where the participant has expressed some kind of thought about what has been apparent to them or more general reflections on what the given information means for them. Reflections on measured dimensions are when the participant has reflected over the values of CO₂ emissions, land use, and/or water use presented in the exhibit. Reflections on plates are defined as moments where the participant has made more general reflections on their TMP and/or OMP as a whole plate. Reflections on products are reflections where the participant has made statements about specific types of food, usually whether they are good or bad for the environment. Examples of each learning type are presented in Table 4.2.

Table 4.2: Examples of each of the seven subgroups within observed and perceived learning.

Learning type	Example
General reflections	“I didn’t know we had a budget” “Creating an OMP is difficult”
Reflections between products	“Apples and eggs have the same amount of emissions” “It was surprising that lamb was so much worse than beef”
Reflections on eating behaviour	“I eat a bad breakfast” “Coffee is bad but I don’t know when I will quit drinking that”
Reflections on learning	“It is difficult to know in the daily life what is environmentally good and bad to eat” “I’ve never thought about where the food comes from”
Reflections on the measured dimensions	“All aspects are important, water usage as well” “Land use doesn’t seem to be the worst one”
Reflections on plates	“The TMP has a greater environmental impact than the OMP” “It surprises me that it takes so much water to produce the things that I usually eat”
Reflections on products	“Coffee consumes a lot of water” “Bread seems to be good for the environment”

4.3.1 Observed learning

Table 4.3 shows which of the seven subgroups occurred most within the result for observed learning. The table shows the amount and percentage of participants that have been coded for a specific subgroup. The result shows that “reflections on products” were the most common type of reflection within observed learning (73 %), followed by “reflections on plates” (65 %) and “general reflections” (27 %). The least common type of reflection within observed learning was “reflections on learning” (4 %).

4. Results

Table 4.3: The observed learning themed into seven different types of reflections. The number of participants in each observed learning theme is presented, followed by the percentage of the total amount of participants in parentheses.

Observed learning	Number of participants	(%)
Reflections on products	37	(73)
Reflections on plates	33	(65)
General reflections	14	(27)
Reflections between products	7	(14)
Reflections on the measured dimensions	6	(12)
Reflections on eating behaviour	3	(6)
Reflections on learning	2	(4)

It was common for the participants to have more than one type of reflection within observed learning; 72.5 % had more than one reflection type and 23.5 % had more than two types of reflections. The most common amount of different reflection types was two (49 %) and the least common amount was zero types (3.8 %). The greatest amount of different reflection types within observed learning was four. Figure 4.12 presents the distribution of how many different types of reflections the participants had.

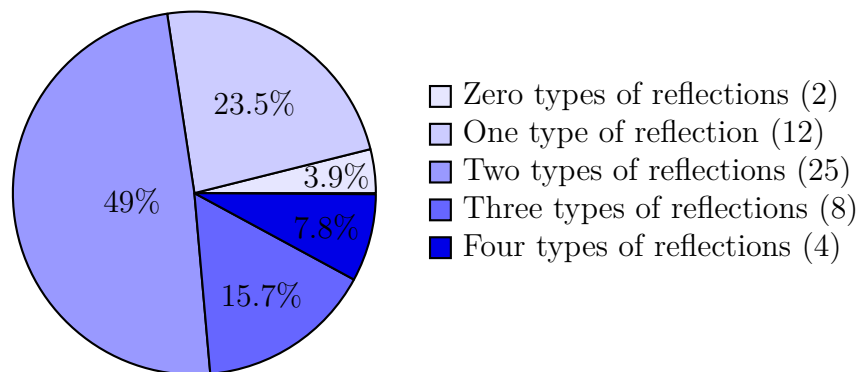


Figure 4.12: The number of different types of observed learning reflections per participant in percent. The number of participants in each group is presented within parentheses in the legend.

A shading matrix was made to evaluate common combinations of two reflection types, see Figure 4.13. A combination of two reflection types means that a participant made both types of reflections in observed learning during the study. The result from the matrix shows that the most common combination of reflection types was “reflections on plates” together with “reflections on products”, followed by “general reflections” together with “reflections on products”. The subgroup “general reflections” is combined with all the other subgroups, which is also the case for the subgroup “reflections on products”. In Figure 4.13, a darker blue color indicates a more common combination while a darker yellow color indicates a more common reflection type within the observed learning.

Reflections	General	Bet. Prod.	On eat. beh.	On learning	On mea. dim.	On plates	On products
General	14						
Between products	2	7					
On eating behaviour	2	0	3				
On learning	1	0	0	2			
On measured dimensions	4	0	1	0	6		
On plates	8	3	2	0	3	33	
On products	11	6	2	1	5	22	37

Figure 4.13: A shading matrix showing the number of intersections between two types of reflections within the theme of observed learning. A darker blue color indicates a larger amount of participants making the combination of the two reflections. The yellow diagonal shows the total amount of participants having each reflection type, where a darker yellow color indicates a more common reflection type.

4.3.2 Perceived learning

Table 4.4 shows which of the seven subgroups occurred most within the result for perceived learning. The table shows the amount and percentage of participants that have been coded for a specific subgroup. The result shows that “reflections on products” were the most common type of reflection within perceived learning (57 %), followed by “reflections on learning” (39 %) and “reflections on measured dimensions” (33 %). The least common type of reflection within perceived learning was “general reflections” (2 %). The spread across different reflection types was greater in the perceived than it was in the observed learning.

Table 4.4: The perceived learning themed into seven different types of reflections. The number of participants in each perceived learning theme is presented, followed by the percentage of the total amount of participants in parentheses.

Perceived learning	Number of participants	(%)
Reflections on products	29	(57)
Reflections on learning	20	(39)
Reflections on the measured dimensions	17	(33)
Reflections on eating behaviour	15	(29)
Reflections on plates	14	(27)
Reflections between products	9	(18)
General reflections	1	(2)

The amount of different types of reflections each participant had within perceived learning is visualized as a pie chart in Figure 4.14. Here the amount of reflections is rather evenly spread across the participants, but most of the participants still had one (25.5 %) or two (25.5 %) different types of reflections. 60.8 % had more than one reflection type and 35.3 % had three or more different types of reflections. The greatest amount of different reflection types was five within the perceived learning result.

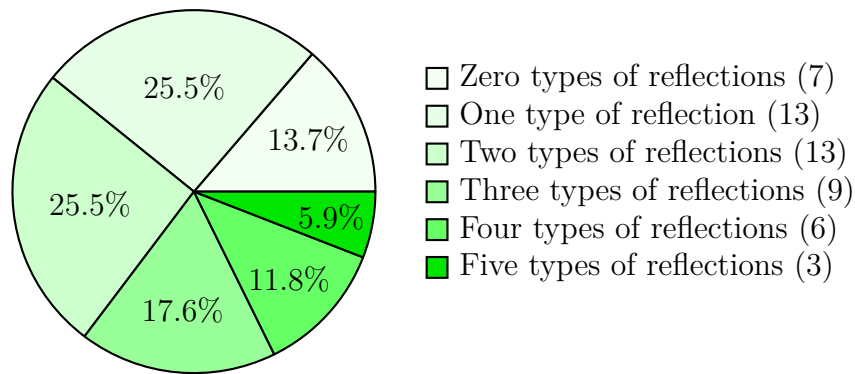


Figure 4.14: The number of different types of perceived learning reflections per participant in percent. The number of participants in each group is presented within parentheses in the legend.

Figure 4.15 shows which combinations of two reflection types within perceived learning were the most common, where a darker green color indicates a more common combination while a darker yellow color indicates a more common reflection. While almost no participants had any “general reflections” within the perceived learning, the combinations of different learning types are rather spread out. The most common combination was “reflections on products” and “reflections on learning”, but other combinations follow closely.

Reflections	General	Bet. Prod.	On eat. beh.	On learning	On mea. dim.	On plates	On products
General	1						
Between products	0	9					
On eating behaviour	0	3	15				
On learning	0	4	9	20			
On measured dimensions	0	4	9	6	17		
On plates	0	3	4	5	5	14	
On products	0	8	11	14	12	9	29

Figure 4.15: A shading matrix showing the number of intersections between two types of reflections within the theme of perceived learning. A darker green color indicates a larger amount of participants making the combination of the two reflections. The yellow diagonal shows the total amount participants having each reflection type, where a darker yellow color indicates a more common reflection type.

4.3.3 Hypothesis testing for observed and perceived learning

Two Mann-Whitney U tests were performed; one for observed learning and one for perceived learning. The null hypotheses were that the distribution of observed/perceived learning is the same across males and females. In addition to this, four Kruskal-Wallis tests were performed; two for looking at the distribution of observed/perceived learning across different age groups and two for looking at the distribution of observed/perceived learning across different educational level groups. The null hypotheses were that the distribution of observed/perceived learning is the

same across all ages/educational levels. All Mann-Whitney U tests and Kruskal-Wallis tests failed to reject the null hypotheses, why nothing can be said about participants of different genders, ages, or educational levels showing different amounts of learning outcomes in either observed or perceived learning (see Appendix C for hypothesis test summary table).

4.3.4 Transformative learning

In the quantitative analysis, it was possible to interpret three different types of learning processes that appeared during the field experiment. The learning processes detected were *support or expand an already existing point of view*, *establish a new point of view* and *transformation of a point of view*. The fourth learning process, *transformation of a habit of mind*, could not be detected within the data set.

Transcribed citations (see Appendix D for the Swedish citations) from the data are presented below as examples of the different types of learning processes. The citation is followed by a comment on why it is interpreted as the specific learning process.

Example - Support or expand an already existing point of view:

I actually knew that ham or that meat is bad for the climate but I did not know how bad it was, as I can see now on the percentage... [...] I was probably a little surprised of how it really is, if it matters so much or not, but now I see that it matters a lot if you eat more meat. (ID nr. 38)

The participant said something that supported or added new knowledge about an already spoken preconception.

Example - Establish a new point of view:

That (*points at the tree icon*) is new to me... I have heard quite a lot about carbon dioxide and water consumption, but I have not thought about the land use aspect before. (ID nr. 57)

The participant said something along the line of “that was new to me”, “I didn’t know that”, or “I haven’t thought of that before”.

Example - Transformation of a point of view:

I still think it (*points at TMP*) looks good for the environment...

...

So, water consumption is not good. Bad that it consumes a lot of wa-

ter there (*points at TMP*). On the other hand, land use... greenhouse gases... It does not feel like it was great, this breakfast was not great for the environment (*points at TMP*). (ID nr. 54)

The participant changed their mind about something they had as a preconception.

4.3.5 Experiential learning

The four learning abilities which Kolb (2015) spoke about were visible to varying degrees among the participants. The first learning ability CE, where learners need to involve in new experiences, is the most prominent since they just by accepting to perform the task involved themselves in a new experience. All participants managed to create both a replica of their usual breakfast and a suggestion of an optimal plate. In addition to this, several of them also expressed interest after they were finished creating the plates for what this experience would yield them, such as

I still believe that the cheese is pretty good. We'll see what, if we learn something, maybe. And we'll take a glass of water! Here's water maybe, but it's sparkling water, isn't it? Well, we'll go with that anyway. We'll see if we learn something. (ID nr. 32)

Tomato could probably be [optimal], depending on... And apple as well, yes. Butter doesn't exist here, does it? Cheese... Okay then. How bad am I? Hahaha... (ID nr. 51)

This kind of interest shows even more that they are openly involved in the experience. The examples above are taken from before any questions about the meal compositions were asked, but many participants also expressed similar thoughts throughout the study. 13 of the participants explicitly stated that creating the OMP was difficult for them, but they tried their best anyway.

The second ability RO, where the learners reflect on their experience from different perspectives, can be seen when the participants interpret the differences between their plates, such as

It depends, it depends a little bit, because if you think of it from a water consumption point of view, if we do that, then that one (*points at TMP*) is the good one. But, carbon dioxide emissions, then that one (*points at OMP*) is the good one. So... It depends on what you focus on, so... Yeah exactly. And, yeah, I can imagine, both are important, but maybe the carbon dioxide emissions are a bit more, that you focus there instead. (ID nr. 9)

I think from a strictly environmental point of view that the best is to, I mean, have as little animal products as possible. But it can be difficult to completely exclude them, but, yeah... (ID nr. 17)

The participants analyze their plates and reflect on the information that is given to them but also make a point to contrast it against another point of view. Many participants stated that the environmental impact wasn't the only important thing to think about when choosing a breakfast in real life; they also emphasized the importance to eat healthy and nutritional.

The third ability AC, where the learner turns their observations into concepts and logical theories, is visible when the learners make more general assumptions based on their observations, such as

And then it depends, yeah, the orange for example, that it takes a lot of water for that, for the farming, in countries which, where they may not have very, I mean, where it becomes a problem with water access. But also that, maybe, dairy products, that it takes a lot of water for that. (ID nr. 8)

No matter what you add it still takes pretty much, on, I mean... On water and, and carbon dioxide emissions and such. Even if you take, like, oat flakes and such, yeah you'd think it would be pretty gentle. But it's still like, it still makes an impact. (ID nr. 10)

After looking at the information given to them and analyzing their observations, they put it together with something else they knew (for example, water usage is a bigger problem in some countries) and make a more general assumption from that; one that the exhibit doesn't give them directly. They realize certain patterns and apply them to other products or things in their everyday life.

The fourth ability AE, where the learner is to make decisions based on their theories, can be observed especially when the participants comment on changes they need to make in their diets such as

I definitely interpret that I, instead of eating yoghurt and, milk, which comes from the animal kingdom, I should take oat milk. (ID nr. 45)

And then definitely, I will choose that one (*points at OMP*) in the future, over this one (*points at TMP*) only because of the, well, the information I got. Mm. [...] And, maybe, change some things a little and... Maybe, focus more on nature, yeah. Or nature, I mean, vegetables, vegetables and fruit, maybe. Yeah, well, I don't eat that much meat but, yeah maybe I could reduce it anyway. (ID nr. 38)

From the theories they had stated based on their observations, they suggested different changes they should make to adapt the newly gained information. 10 out of the 51 participants explicitly stated that they needed to change what they eat. When asked "if you wanted to learn more about this, what kind of information

would you look for?”, many participants answered something that would deepen their understanding of their theories. This indicates that they would like to make decisions about their eating behaviour, but with more facts and information to make a legitimate choice. All transcripts in subsection 4.3.5 can be found in their original language (Swedish) in Appendix D.

4.3.6 Non-learning and mislearning

In the data set the two psychological mechanisms *defense* and *resistance* which are described in Section 2.2.3 could be recognized in some participants. Four participants said something that could be interpreted as a defense towards learning about food consumption in general and fifteen participants said something that could be interpreted as resistance towards learning occurring due to the activity itself.

The defense mechanisms were interpreted for statements along the line of “this isn’t relevant for me to know”, “I already know what I need to know” and “I don’t understand things like this” (“I am too stupid”) where the meaning of the wordings was “I don’t want to learn because it means that I must change something about myself” (with no connection to the type of learning activity). The resistance mechanism was interpreted for statements such as “I didn’t learn that much because I felt monitored and pressed”, “I need more time to learn”, “it’s too many impressions here, I get overwhelmed” or “I can’t learn things in this context” where the meaning of the wordings was “I didn’t learn that much because of the learning activity itself”.

Moreover, mislearning occurred due to interpretation problems or uncertainty on how to interpret the data visualizations on the climate-smart exhibit. Within the data set of a total of 51 participants, 24 participants were uncertain or had problems interpreting the data visualization to some extent, and six participants misunderstood the data visualizations in some way. Figure 4.16 presents the number of participants who used a psychological mechanism against learning and the number of mislearning occurrences among the data set’s participants. The same participant can be listed twice or more in Figure 4.16, depending on if the same participant was coded for several non-learning and mislearning behaviours. For instance, 73 % of the participants who had interpreted resistance towards learning also had problems interpreting the data visualization, which means that it is likely that someone who had problems interpreting the data also showed resistance towards learning and maybe also misunderstood the data visualizations.

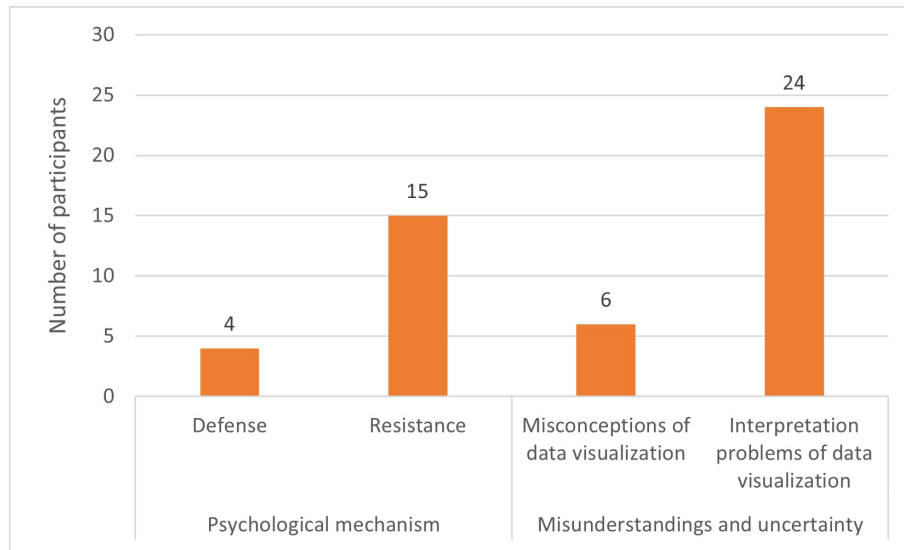


Figure 4.16: The number of participants with non-learning or mislearning behaviour.

In Figure 4.17 and Figure 4.18 the number of participants with non-learning and mislearning behaviour are categorized into gender and age. In this study, the males were more likely to use defense mechanisms whereas the females were more likely to use resistance mechanisms towards learning. Furthermore, the females had more problems with interpreting the data visualizations than the males had. The upper age span turned out to be more uncertain about the data visualizations, while the lower age span had a higher number of participants with misunderstandings. However, due to few participants in the categories the result in Figure 4.17 and Figure 4.18 must be interpreted with critical caution.

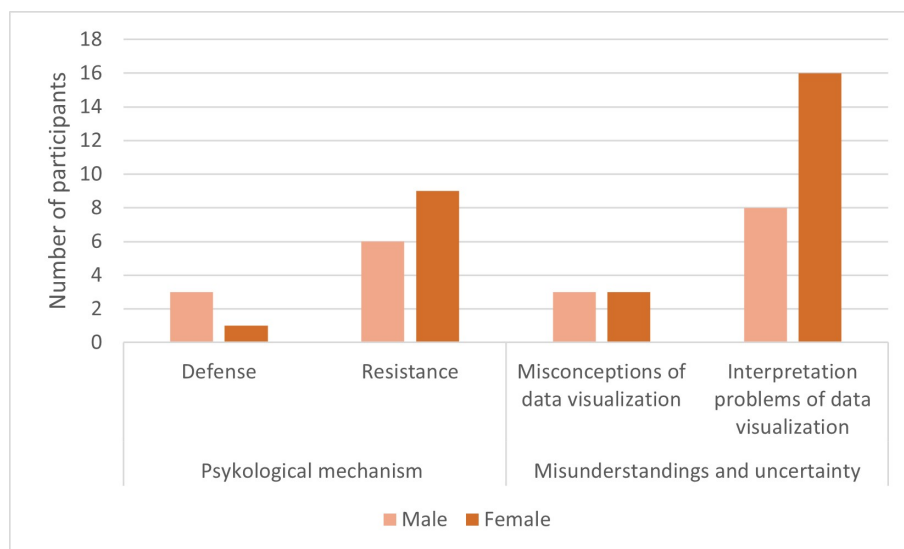


Figure 4.17: The number of participants with non-learning or mislearning behaviour, categorized by gender.

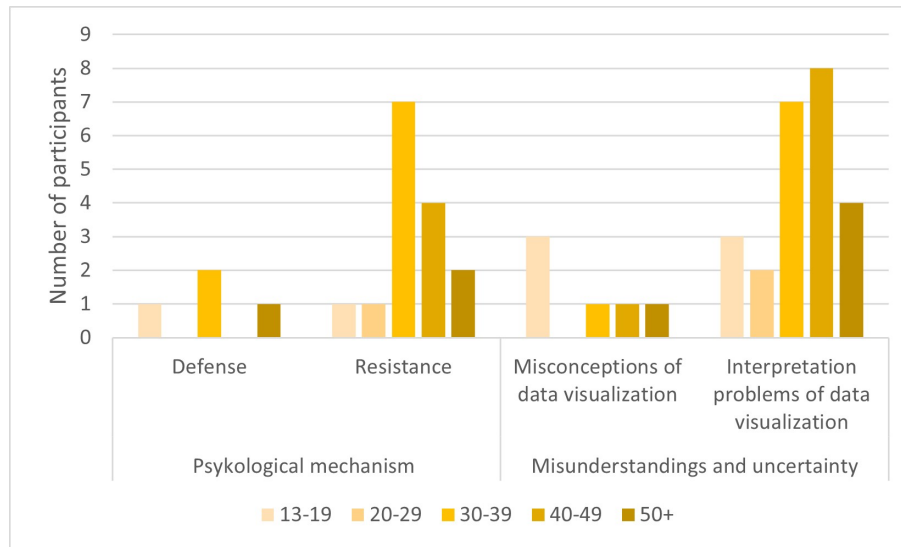


Figure 4.18: The number of participants with non-learning or mislearning behaviour, categorized by age.

The major interpretation problems of data visualization were about the percentages of the environmental aspects or about the diagram, which is the exhibits' mathematical visualization. The participants were uncertain if the presented percentages for their plates were per day or meal. Some participants were even uncertain if it was good or bad to have a high percentage, and what the meaning of the percentages was. The diagram with the bar comparison for the picked food items on the climate-smart exhibit made some participants uncertain about if long bars were good or bad, how to relate the bars to the percentages, why the bars had different lengths, and if the bars were explaining a relation between the picked food items or not. Transcribed citations from the data set are presented below for typical uncertainty quotes when the participants tried to interpret the data visualizations (see Appendix D for the original Swedish citations).

Examples - Misunderstandings and uncertainty:

I actually do not know how to interpret these [percentages], but 0 %, so they -, this must include... [...] But I do not know what it is the percentage of, actually. So, I do not know. Eh... No, I actually don't know... [...] I think it's a bit strange, so, if this is going to be some kind of information about if it is good or bad, then you probably would have liked some, I do not know... The percentage (*points at OMP drop icon*), it becomes like nothing that becomes... To achieve the proposed water consumption, it requires a value of less than 328 liters (*reads the icon text*). Mm. But what, two percent, of what? (ID nr. 33)

We shall see here... 52 % of the proposed budget for water consumption. Is it for a full day then, or for this meal? (*points at TMP diagram*) Coffee, oh it consumes a lot, coffee! Mm. The ham and, the banana...

And then the cheese... No but I... If we look at this (*point at OMP drop icon*) then... To achieve the proposed goals for water consumption a value is required that is, less (*reads the icon text*)... No, yes, but then, I just do not understand if this is, is this per meal, this is, or, this water consumption? Or is it for a whole day? (ID nr. 44)

They don't have the equal length (*points at bars in the diagram*), why not? [...] Well, then it didn't function the way I thought, because I thought that if everything is the same [amount], the bars will be of the same length. (ID nr. 54)

Some of the interpretation problems also became the participants' misconception of the data visualization; for example, the uncertainty about if the percentages were per meal or per day. This misconception resulted in a participant thinking that it was okay to eat a lot of meat and that the participant could eat an extreme amount of food items for breakfast. Other misconceptions were that the percentages are of the average human consumption or that the climate-smart exhibit was about what people from different countries eat. Two misconceptions are presented below with transcribed citations from the data set (see Appendix D for the original Swedish citations).

Examples - Misconception:

And then there is quite a small area used for this, I could take five such portions in comparison with what is here on the plate. So, this is like, a pretty good, uh, plate where you could like, take it three times, maybe. Increase with maybe steak or something, maybe... [...] Here, it looks pretty good (*looks at icons*). Or 102 %, yes... Yes, but it works. Yes, but that, that's how I could eat also... (ID nr. 37)

So, it's about what you eat in different continents, maybe? (*presses the symbol in the middle of the table, nothing happens*) (ID nr. 51)

4.3.7 Hypothesis testing for non-learning and mislearning

Two Mann-Whitney U tests were performed; one for interpretation problems of data visualization and one for misconceptions of data visualization. The null hypotheses were that the distribution of interpretation problems/misconceptions is the same across males and females. In addition to this, four Kruskal-Wallis tests were performed; two for looking at the distribution of interpretation problems/misconceptions across different age groups and two for looking at the distribution of interpretation problems/misconceptions across different educational level groups. The null hypotheses were that the distribution of interpretation problems/misconceptions is the same across all ages/educational levels. All Mann-Whitney U tests and Kruskal-Wallis tests failed to reject the null hypotheses, why nothing can be said

4. Results

about participants of different genders, ages, or educational levels showing different amounts of non-learning behaviour (see Appendix C for hypothesis test summary table).

5

Analysis of results and discussion

In this chapter, both the method used in this study and its results will be analyzed and discussed. The climate-smart exhibit used in this study will be evaluated as well.

5.1 Results

Even though some participants suggested an empty plate when asked to create an OMP, all participants managed to create an OMP and expressed more or less their reasoning behind their choices. There were significant differences between the TMP and OMP in all environmental aspects, indicating that visitors often have a rather good perception of what environmentally-friendly food is but don't eat accordingly. This is the opposite of what the study by Macdiarmid et al. (2016) shows, where the participants thought that meat consumption had a minor role in the environmental impacts globally. However, as stated in Section 1.3 and since many participants admitted that less food means less environmental impact, there is a possibility that the OMP contains too few food items and/or nutrients and therefore makes the participants hungry soon again. This could lead to more snacking and a larger meal for lunch, making the environmental impact for the entire day larger than it would if they had eaten their TMP instead.

5.1.1 Gender, age, and educational background

Although only 37.87 % of Gothenburg's citizens have an educational level of "College, University (longer education - completed degree)" (Statistics Sweden, 2022), it was the most common educational level in this study with 58.8 % of the participants. This could be due to Universeum maybe attracting more visitors with higher educational backgrounds, since it would not be strange if people who are already heavily interested in natural sciences bring their children to science museums, trying to spark an interest in their kids as well. However, there were no significant differences in environmental impacts on the OMP when looking at different educational level groups, indicating that educational level may not matter that much when looking at knowledge about environmentally-friendly food. The only environmental aspect with significant differences between the educational level groups was the water use on the TMP, which only means that people of higher educational level today usually eat a worse breakfast in regards to water use than people with a lower educational level do. Particularly participants with an educational level of "College, University

(up to 2 years)” had a high water usage on their TMP; their mean percentage of a daily budget was 63.83 %. The second highest mean value was 38.00 % and belonged to the educational level group “College, University (longer education - completed degree)”. All participants in the educational level group “College, University (up to 2 years)” included coffee, a highly water-consuming food item, on their TMP, which could help to explain why their water usage was so high.

Overall, not many significant differences between different population groups regarding the environmental aspects could be found. Significant differences in the TMP could only be found between the educational level groups, whereas significant differences in the OMP could only be found between the two genders. The two genders had significant differences in their OMP in regards to both CO₂ emissions and water use where females had higher values than males in both aspects. The fact that they had higher values is maybe not so strange considering how they on average put 28.76 % more food items on their OMP than the males did. They also chose apple and egg on their OMP to a greater extent than the males did. Perhaps the females reasoned that they wanted to eat a varied diet and choose something they still think tastes good and can consider eating. The males often chose sparkling water, oat flakes and oat milk, which the females might think is a bit too plain taste-wise. In the study by de Boer and Aiking (2022) the result showed that their participants considered a healthy and sustainable diet to include a variety of food, fruits and vegetables, and in general vegetarian or vegan food consumption. This may comply with the participants’ choices of food items for their OMP in this study as well.

Significant differences between the age groups could not be found. It seemed like the older participants generally picked more food items on both their TMP and their OMP than the younger participants did. For example, the age group 40-49 picked 324.86 % more food items for their TMP and 249.48 % more food items for their OMP than the age group 20-29 did. This could be due to younger people eating less breakfast than older people do.

5.1.2 Common learning outcomes

The way this study was conducted, where the participants first had to create a TMP and thereafter an OMP, can have greatly impacted the learning outcomes for the participants. The reason to introduce the tasks in that specific order was to try and make the participants discover the environmental aspects themselves and spot the eventual differences. Without this way of working, it is not sure if as many participants had made such deep comparisons between their plates, and triggered the same types and/or amounts of reflections.

Both oat milk and oat flakes were popular picks for many participants; 37.25 % chose oat milk and 64.71 % chose oat flakes for their OMP. Interesting to note is that oat milk was considered environmentally friendly even though it consumes a lot of water. While 19 participants chose to put oat milk on their OMP, only ten

commented that oat milk seems to be environmentally bad. Perhaps oat milk is considered environmentally friendly on the basis that it is a vegan alternative to milk, and a lot of people associate a vegan diet with an environmentally-friendly one. As stated in Section 4.3, ten participants expressed how the OMP should probably not include any animal products while many more commented in less general terms that it should not include meat and/or dairies specifically. The idea that vegan food is environmentally good per default could be a potentially important misconception among the participants.

Many participants were shocked when confronted with the high water usage from coffee. They showed resistance to changing their coffee habits and preferred to exclude other food items from their plates. Perhaps this is due to the lack of coffee substitutes. While not all people want to change milk to oat milk, or meat to soy products, they know they can if they ever feel the need to. There are substitutes for most groceries where the nutritional content and in many cases even the taste are preserved. For coffee, however, there is no clear, equivalent substitute to switch to. This seemed to cause more reactions among the participants when faced with the new information and an increasing panic about how they will ever be able to quit drinking coffee. In general, water consumption seemed to be a new aspect for many participants to think of. Several of them expressed that media constantly serves them with information about CO₂ emissions and that we all must convert to a vegan diet to have enough land area to grow crops for all the people on Earth, but information about water usage is not as prominent. Maybe this is due to Sweden not lacking in water supply, and people therefore taking it for granted.

Out of the fifty-one participants, eleven explicitly stated that they did not learn anything by performing the tasks. However, only one out of these eleven participants actually showed no signs of learning. In other words, ten participants (19.61 % of all participants) denied any occurred learning while this study indicates the opposite. Five out of the eleven participants had just moments before expressed something that either was surprising to them, particularly interesting, or both. This indicates that people maybe learn things even if they don't always think so themselves. Interestingly to note is also that 40 % out of the ten participants who, in contrast to this study's findings, denied any occurred learning were in the age group 40-49. Among all participants the age group 40-49 only represents 13.7 %, indicating an over-representation of people in the age span 40-49 not believing they learned anything despite signs of it. However, the sample size of ten participants is very small and may not be representative of the entire population.

5.1.2.1 Observed and perceived learning

The distribution of observed and perceived learning was the same across both genders, even though the males produced OMPs with significantly lower environmental impact. This shows that the results from creating the OMP did not affect to what extent the participants could still draw conclusions and learn from their performances. The hypothesis tests performed could not detect any significant differences in the number of learning outcomes within observed or perceived learning among ei-

ther gender, age, or educational level groups. This indicates that the climate-smart exhibit is suitable for educating visitors of all genders, ages, and educational backgrounds about environmentally-friendly food, which is what Universeum hopes for. As stated before it is, however, possible that the study's setup has had an impact on the participants' learning outcomes, and that completely free exploration would have given different results.

The most common reflection type in both observed and perceived learning was a reflection on products. This is a relatively easy reflection for the participants to make by just looking at the screen, without having to draw too many parallels or conclusions. The number of reflections made could say something about the amount of learning happening. However, the results only tell us how many different types of reflections each participant has made and not how many reflections they have made in total. One participant could have made several reflections but all are categorized as the same type, resulting in them only having one type of reflection. This way of presenting the data is made since it is very difficult to establish a clear line of when one reflection ends and a new one begins if both reflections are of the same type. Is it a new reflection, or is it a further development of the last one?

It is quite interesting to see that as many as 20 participants (39.22 %) have expressed reflections on their own learning; they reflect upon their knowledge gaps and how to best fill them. Since the two questions "did you learn anything" and "if you wanted to learn more about this, what kind of information would you look for" were asked, it is not too astonishing that they reflected upon learning, but it is still a positive outcome that the climate-smart exhibit can stimulate the thought process on deeper subjects than reflections about specific food items.

Since reflections about products were the most common reflection type among both observed and perceived learning, it is not that remarkable that it also is a part of many common combinations of two learning types among the participants. In observed learning, the most common combination of two learning types that did not include reflections on products was the combination of reflections on plates and general reflections (8 participants; 15.69 %). This type of reflection combination seems to be most prominent at the beginning of performing the tasks when the participants express general thoughts about the task and exhibit. In perceived learning, the most common combination of two learning types that did not include reflections on products was the combination of reflections on eating behaviour together with either reflections on learning (9 participants; 17.65 %) or reflections on measured dimensions (9 participants; 17.65 %). Reflections on eating behaviour include statements such as "I should change what I eat" and "I eat a bad breakfast". It doesn't seem too remarkable that it is often combined with reflections on measured dimensions, where the participants have made statements such as "everything has an impact" and "it is interesting to see the water usage". When participants comment on the environmental impact of their plates, it sounds logical that some of them thereafter conclude that they need to change something in their diet to reduce the environmental impact they just commented on. The combination of reflections on eating

behaviour and reflections on learning seems logical too; when participants reflect on their learning and comment on aspects they should think more about, continuing by drawing parallels to their eating behaviour sounds reasonable.

5.1.2.2 Learning theories

Signs of the learning theories transformative, experiential, and non-learning/mislearning could all relatively easily be identified within the data set. Therefore, the learning theories are argued to be natural and suitable learning models to describe how learning and non-learning can occur in this learning environment and context.

In the result of transformative learning theory, three out of four of the learning processes Mezirow (1997) describes (see Section 2.2.1) could be identified in the data set. The learning process not recognized was the fourth one “*transformation of a habit of mind*”, which can be due to it being more complex to achieve since it takes time to change a habit. Transformative learning theory is therefore considered able to describe much of the learning happening at visualization exhibitions but is difficult to measure if the study doesn’t follow the participants during a longer period. As described in Section 2.2.1, *transformation of a habit of mind* could occur if the participants had several transformations of a *point of view*, where the new information had to contradict an already strong belief of the participant. Maybe the fourth learning process could also occur in an experiment where the participants could ask the researcher questions and have time to investigate an already existing belief further. For example, a participant might strongly believe that locally produced food is environmentally-friendly because that is what he or she has learned in school and through political environment discussions. If he or she then several times experiences how all food items they think are locally produced turn out to be environmentally worse than the food items they believe not to be locally produced, a *transformation of a habit of mind* could be that the participant now thinks that locally produced food is terrible for the environment.

The four learning abilities *concrete experience* (CE), *reflective observation* (RO), *abstract conceptualization* (AC), and *active experimentation* (AE) from the experiential learning cycle by Kolb (2015) were all visible within the data set. Due to all four of the abilities being recognized quickly among the participants, it seems to be a well-suited learning theory to implement as a learning model for the learning outcomes in this study. The general perception among the researchers in this study is that all four learning abilities were prominent several times spread out among the participants, and that experiential learning could help greatly in explaining the kind of learning the climate-smart exhibit can generate.

Despite the results showing that 98.03 % (50 out of 51) of the participants learned something at the climate-smart exhibit, almost half (24 out of 51; 47.05 %) of the participants had uncertainty or problems interpreting the data visualization, and six participants (11.76 %) misunderstood the data visualization. In other words, the shared DVL (data visualization literacy) responsibility Kirk (2020) spoke about between the illustrator, who must make the data understandable, and the user, who

must be willing to obtain DVL abilities, has failed to some extent. Either the illustrator has not made the data visualizations simple and obvious enough, or the visitors' previous experiences, culture, knowledge and/or lack of DVL hinder them in deciphering the visualizations. It can also be a combination of several causes.

It was more common to have *resistance* (29.41 %) than *defense* (7.84 %) mechanisms towards learning. Furthermore, the females more commonly showed resistance mechanisms toward learning than the males did. This could be influenced by more females having problems interpreting the data, which led to them showing frustration through a resistance comment, such as “there are too many impressions here, I get overwhelmed”. On the other hand, the males showed more common defense mechanisms toward learning, which could indicate that the males were more likely to stick to their own beliefs and not open to changing their meals even if they saw their environmental impact. Overall, the age groups 30-39 and 40-49 more commonly showed resistance towards learning which follows the trend of them having the most trouble with interpreting the data. The age group most likely to misunderstand the data was 13-19, which perhaps can be explained by the environmental issues being rather difficult concepts and more difficult to interpret for the younger visitors who don't have as much experience.

The hypothesis test about if there are any differences between the groups of gender, age, or educational level, and the amount of non-learning or mislearning behaviour showed no significant differences. Even when analyzing if there were any differences between the groups regarding the amount of the learning outcomes, no significant differences could be found. In other words, it did not matter whether you are male or female, young or old, uneducated or highly educated; the learning outcome and non-learning/mislearning results were comparable. The *Vislab* exhibit, according to the results, matches its target group of 13+ due to the independence of the visitor's background.

5.2 Method

All participants in the study were visitors at Universeum who freely chose to enter the exhibition *Vislab*. The high representation of participants having an educational level of “College, University (longer education - completed degree)” perhaps says something about the kind of people who usually visits Universeum and *Vislab*. To better mirror the general public, one could conduct the field experiment by choosing citizens randomly, or by recruiting groups representing different population groups, to participate in the study. While the results in this study do say a lot about thoughts and perceptions among the visitors at Universeum and perhaps among people in general who like to visit science centers, it can be questioned whether or not the conclusions from the study apply to the society as a whole.

When planning the field experiment, a choice was made to not let the participants work together in pairs or smaller groups while performing the tasks or answering the interview questions. However, during the field experiment, it was clear that many of

the participants sought for advice or at least someone to exchange ideas with, either from a friend or family member or from the researchers. It can also be argued that most visitors when exploring the climate-smart exhibit outside of the study, will often do so in the company of others with whom they can discuss and argue about the data presented to them. Having people participating in the study in pairs or smaller groups would maybe give a more fair picture of what people take an interest in and learn from the exhibit. The decision to only let participants work individually was made since it would otherwise be difficult if not impossible to compare different genders, ages, and/or educational levels with each other. It would also be more complicated to sort out what different participants learn from the experience if their answers are entangled with other people's answers. The way this study was performed, with individual participants, has probably decreased the significance of what people can learn from similar exhibits since the learning situation in this study is not fully natural. On the other hand, the study can provide results concerning differences in perceptions of what is considered to be environmentally-friendly food among visitors of different genders, ages, and educational levels.

As stated in Section 3.3, the choice to not video record any participants was made due to the risk of accidentally including non-participants in the video. Instead, audio recordings combined with a documenter writing down actions and gestures were used. However, a documenter can never fully capture the entire scene with body language and facial expressions as well as a video recording can. The use of video recordings would probably further improve the analysis and outcome of the study but would require a more isolated exhibit and/or the participants to stand in a specific spot and not move around too much to avoid recording non-participants. This was thought to constrain the participants more than it would benefit the study.

The thematic text analysis was done inductively. The inductive way of working made it possible to detect the learning processes and learning abilities, but it was difficult to say to what extent they were present. As for the non-learning and mislearning, the inductive coding already made was relatively easy to transform into the number of participants showing each mechanism described. In addition to this, the inductive way of working gave some rather interesting, unpredictable results such as 19.6 % of the participants expressing that they did not learn anything even if there were clear indications of learning during their actions and 73.3 % of all participants who put coffee on their TMP realizing its high water usage. Perhaps these findings would not have been detected if a theory-driven, deductive approach had been used where pre-determined theories and suppositions work as a foundation for analyzing the data. A deductive approach can be good when looking for certain patterns and trends and provides logical conclusions about the investigated case. However, since this thesis had no clear results or expected outcomes in mind, the inductive way of working was believed to be better at giving a more complete, non-biased picture of the data set.

5.3 Exhibit

The fact that 45.1 % of the participants expressed a belief that the origins of the food matter environmentally indicates that people associate environmentally-friendly food with locally produced food, maybe more than they associate it with the environmental aspects specifically. However, the climate-smart screen at *Vislab* does not tell the visitors where the food comes from. This can confuse the participants who believe it to be a central aspect; as Ma et al. (2012) stated, the access to background information for enhanced understanding is of great importance and something that visitors often ask for. Information given to the researchers (but not the visitors) explained that the country of origin for the food items was the country where most of each specific food item came from. For example, the most commonly bought lamb steak comes from New Zealand, therefore environmental impact data (CO₂ emissions, land use, and water use) for lamb steak is calculated based on New Zealand as the country of origin. As stated, the data about the country of origin is not available to the visitors so if they usually opt out of groceries not locally produced, their results from the climate-smart exhibit could be heavily misleading.

Another question among the participants was about the nutritional aspect; they found it confusing to discard that aspect when creating their OMP and weren't always sure about the nutritional content when looking at substitutes for what they usually eat. The nutritional information is also absent from the climate-smart exhibit and while the number of participants asking for it was not near as many as the number of participants asking for information about the origins of the food, it is still an aspect that is crucial for many people when deciding what to eat.

The information from the climate-smart exhibit which caused the most confusion among the participants were the percentages of the environmental aspects; whether or not they were per meal or per day. The uncertainty caused many participants to doubt their reasoning and conclusions in general, since they weren't sure if they were based on correct assumptions. Some participants assumed that the percentages were per meal and were very happy about their breakfast for example "only using 46 % of the water budget", not realizing that the remaining 54 % would include both lunch, dinner, and any eventual snacks. This vague description of the percentages in the climate-smart exhibit is directly dangerous since visitors could leave the exhibit with completely false perceptions of what environmentally-friendly food is, which would negate the exhibit's entire purpose.

6

Conclusion

In this chapter, conclusions about the study's research questions will be presented. Furthermore, ideas for future work will be proposed.

6.1 Answers to research questions

How do visitors choose food items for a typical meal for them compared to their idea of an environmentally optimal meal?

The participants' thoughts about the most environmentally-friendly food seemed to be oat flakes, oat milk, apple, sparkling water, and egg, while the participants seemed to eat/drink more coffee, bread, oat flakes, cheese, and yoghurt for their typical meal. Furthermore, there were significant differences between the TMP and the OMP among the participants, which means that *Vislabs'* visitors know how to reduce their impacts for their typical first meal but don't eat accordingly in practice.

Is the information provided by the climate-smart exhibit clear to the visitors, or are there indications of misinterpretations during the interactions? Were there any differences regarding misinterpretations related to gender, age, or educational background?

Twenty-four of the participants indicated having a problem or were uncertain about how to interpret the data visualization. Within non-learning and mislearning, both the *defense* and the *resistance* mechanisms were present among several of the participants, where females and older participants were keener to show signs of the *resistance* mechanism while males more often displayed *defense* mechanisms. Only six participants misinterpreted the data and according to the hypothesis tests, there were no significant differences in the amount of non-learning or mislearning behaviour between the population groups.

What do the visitors' environmentally optimal plates tell us about their view on climate-smart food consumption? Were there any differences regarding gender, age, or educational level?

Many participants commented on locally produced food, in general, being the best for the environment and seemed to try to pick food items according to that. Significant differences between the genders' CO₂ emissions and water use from their OMP

can indicate that the males have more knowledge about what is environmentally friendly or that they were more task orientated than the females when performing their OMP. The females may have created an OMP that they can consider eating in the future, but we don't know their underlying intention and rationale behind their OMP. No significant differences between groups of age or educational level regarding their environmental impact on their OMP were found.

What indications of learning can be revealed/identified during the visitors' interactions with the climate-smart exhibit?

The climate-smart exhibit and the study generated insights such as "I should eat my OMP in the future" or "my OMP was better/worse than my TMP". In general, coffee was the food item causing the most shocking reactions when the participants realized its negative environmental impact. Most participants seemed to learn about specific food items, but many also made comments about how they need to change their diet, indicating that the climate-smart exhibit accomplished to generate a bit deeper "lessons learned" among the participants. To accept new information that contradicts what we already believe, exploring and investigating the information on our own through transformative and experiential learning seems like a successful concept to counteract the *defense* and *resistance* mechanisms of the non-learning theory.

6.2 Future work

Interesting future work for the project would be to investigate the learning outcome in a more social context, where the participants work in pairs or groups and compare it to the learning outcomes from this study. This would add a more accurate picture of the natural learning outcomes from the climate-smart exhibition due to most visitors investigating the exhibits at *Vislab* together with friends or family. Moreover, a comparison between the results from the pairs/groups and this study's results could show if and in that case how the results are affected by the social context.

Another possible future study would be to compare the possible learning outcome from the climate-smart exhibit with the possible learning outcome from a more traditional learning environment lacking the personal and interactive aspect, such as a textbook or movie. If the contents are the same, is it possible to spot any differences in how much learning the learners can gain and then say something about the potential of visualization?

Bibliography

- Bada, S. O., & Olusegun, S. (2015). Constructivism learning theory: A paradigm for teaching and learning. *Journal of Research & Method in Education*, 5(6), 66-70.
- Braun, V., & Clark, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Börner, K., Bueckle, A., & Ginda, M. (2019). Data visualization literacy: Definitions, conceptual frameworks, exercises, and assessments. *Proceedings of the National Academy of Science*, 116(6), 1857-1864. <https://doi.org/10.1073/pnas.1807180116>
- de Boer, J., & Aiking, H. (2022). Do EU consumers think about meat reduction when considering to eat a healthy, sustainable diet and to have a role in food system change? *Appetite*, 170, 105880. <https://doi.org/10.1016/j.appet.2021.105880>
- Devore, J. L. (2016). *Probability and Statistics for Engineering and the Sciences* (9th edition). CENGAGE Learning.
- Green, D. P., & Gerber, A. S. (2004). Field Experimentation. *Encyclopedia of Social Measurement*, 19-24. <https://doi.org/10.1016/B0-12-369398-5/00003-7>
- Hansen, J., & Tummers, L. (2020). A Systematic Review of Field Experiments in Public Administration. *Public Administration Review*, 80(6), 921-931. <https://doi.org/10.1111/puar.13181>
- Hjerpe, K., Markensten, T., Pearsson, M., Rundberg, B., Lundström, A., Rydberg, I., Sonesson, U., & Nilsson, K. (2013). Hur liten kan livsmedelskonsumtionens klimatpåverkan vara år 2050 - ett disussionsunderlag om vad vi äter i framtiden [How small can the environmental impact from food consumption be in 2050 - a discussion material about what we eat in the future]. Swedish Board of Agriculture, Swedish Food Agency and Swedish Environmental Protection Agency. <https://www.livsmedelsverket.se/publikationer/sok-publikationer/artiklar/2013/2013-hur-liten-kan-livsmedelskonsumtionens-klimatpaverkan-vara-ar-2050-ett-diskussionsunderlag-om-vad-vi-ater-i-framtiden>
- Illeris, K. (2003). Towards a contemporary and comprehensive theory of learning. *International Journal of Lifelong Education*, 22(4), 396-406. <https://doi.org/10.1080/02601370304837>

- Kirk, A. (2020). Data Visualisation Literacy - Learning to See. *Contabilidad y Dirección*(31), 37-48.
- Kolb, D. A. (2015). *Experiential learning: Experience as the Source of Learning and Development* (2nd edition). Pearson Education.
- Lag om etikprövning av forskning som avser människor [Act on Ethical Review of Research about People] (SFS 2003:460). Ministry of Education and Research. https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/lag-2003460-om-etikprovning-av-forskning-som_sfs-2003-460
- Ma, J., Liao, I., Ma, K.-L., Fellow, IEEE, & Frazier, J. (2012). Living Liquid: Design and Evaluation of an Exploratory Visualization Tool for Museum Visitors. *IEEE Transactions on Visualization and Computer Graphics*, 18(12), 2799-2808. <https://doi.org/10.1109/TVCG.2012.244>
- Ma, J., Ma, K.-L., Fellow, IEEE, & Frazier, J. (2020). Decoding a Complex Visualization in a Science Museum - An Empirical Study. *IEEE Transactions on Visualization and Computer Graphics*, 26(1), 472-481. <https://doi.org/10.1109/TVCG.2019.2934401>
- Macdiarmid, J. I., Douglas, F., & Campbell, Jonina. (2016). Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet. *Appetite*, 96, 487-493. <https://doi.org/10.1016/j.appet.2015.10.011>
- McDermott, R. (2004). Experiments, Political Science. *Encyclopedia of Social Measurement*, 901-909. <https://doi.org/10.1016/B0-12-369398-5/00326-1>
- Mezirow, J. (1978). *Education for perspective transformation: Women's re-entry programs in community colleges*. Center for Adult Education, Teachers College, Columbia University.
- Mezirow, J. (1997). Transformative learning: Theory to practice. *New directions for adult and continuing education*, 1997(74), 5-12.
- Mezirow, J., & Associates. (2000). *Learning as transformation: Critical perspectives on a theory in progress*. San Francisco, CA: Jossey-Bass, Inc.
- Phillips, D. C., & Soltis, J. F. (2014). *Perspektiv på lärande* [Thinking About Education: Perspectives on Learning] (2nd edition). Studentlitteratur.
- Scholnik, M., Kol, S., & Abarbanel, J. (2006). Constructivism in theory and in practice. *English teaching forum*, 44(4), 12-20.
- Statistikmyndigheten SCB [Statistics Sweden]. (2022). *Utbildningsnivån i Sverige*. [Dataset]. <https://www.scb.se/hitta-statistik/statistik-efter-amne/utbildning-och-forskning/befolkningens-utbildning/befolkningens-utbildning/pong/tabell-och-diagram/andel-hogutbildade-i-befolkningen-2564-ar-fordelade-efter-kommun-fallande-ordning/>

- Taylor, E. W. & Clanton, P. (2012). Mezirow's theory of transformative learning from 1975 to present. *The handbook of transformative learning: Theory, research, and practice*, 99-115. John Wiley & Sons.
- Thomas, D. R. (2003). *A general inductive approach for qualitative data analysis*. School of Population Health, University of Auckland.
- Universeum AB. (February 8 2022). Vislab. <https://www.universeum.se/upplevelser/vislab/>
- Ynnerman, A., Löwgren, J., & Tibell, L. (2018). Explorations: A New Science Communication Paradigm. *IEEE Computer Graphics and Applications*, 38(3), 13-20. <https://doi.org/10.1109/MCG.2018.032421649>

A

Information to participants

Participation in a research study

You have participated in a research study today, conducted by two students at Chalmers master's program " Learning and Leadership". The study seeks to investigate possible learning outcomes through interactive data visualization. Your anonymous identification number is:

The information collected about you is your gender, age, educational background, and a voice recording of what you have said during the survey. You can at any time revoke your consent to being part of the study and all stored data regarding you will then immediately be deleted.

If you wish to revoke your consent, please contact the researchers at sanlov@student.chalmers.se or Imalou@student.chalmers.se. State your anonymous identification number and that you no longer wish to be a part of the research study. You will receive a confirmation email once all data regarding you has been deleted.

Thank you for your participation!

Figure A.1: The note all participants were given after participating in the study.

B

Environmental budget according to *Vislab*

Below is a table that shows the amount of CO₂ emissions, land use and water use for each food item according to the climate-smart exhibit at *Vislab*. All values are calculated per 100 grams, consumed every day for a year.

From the data, the yearly sustainable budget for each person has been calculated to 3910.6 kg CO₂ emissions, 6901.8 m² land use and 117.0 m³ water use. The daily sustainable budget for each person is then 10.7 kg CO₂ emissions, 18.9 m² land use and 0.3 m³ water use.

Table B.1: Measured values for each food item according to the climate-smart exhibit at *Vislab*. The values for each food item are for consumption of 100 grams, every day for a year.

Food item	CO ₂ (kg/%)	Land use (m ² /%)	Water use (m ³ /%)
<i>Fruits and vegetables</i>			
Apple	6.4/0.2	7.3/0.1	1.8/1.5
Banana	57/1.4	20/0.3	7.9/6.6
Broccoli	47/1.2	36/0.5	0.599/0.5
Cabbage	13/0.3	4.6/0.1	0.110/0.1
Carrot	8.4/0.2	6.9/0.1	0.146/0.1
Grapes	28/0.7	33/0.5	0.266/0.2
Orange	19/0.5	11/0.2	3.1/2.6
Peas	132/3.3	131/1.9	26/21.5
Potato	5.8/0.1	9.6/0.1	0.316/0.3
Strawberry	54/1.4	13/0.2	9.3/7.8
Tomato	28/0.7	2/0	0.730/0.6
<i>Protein and dairy</i>			
Beef file	1500/38.3	1754/25.1	13/10.9
Cheese	91/2.3	15/0.2	0.523/0.4
Chicken	91/2.3	123/1.8	3.6/3
Cod	239/6	6.1/0.1	17/14
Egg	70/1.8	67/1	6.3/5.3
Ham	115/2.9	141/2	7/5.9

B. Environmental budget according to *Vislab*

Lamb and goat steak	1900/47.5	3056/43.7	4.8/4
Milk	148/3.7	36/0.5	17/14.2
Pork file	296/7.4	224/3.2	1.5/1.2
Pork sausage	280/7	164/2.3	1.7/1.4
Tofu	60/1.5	105/1.5	1.9/1.6
Yoghurt	85/2.1	20/0.3	8.6/7.1
<i>Grains and snacks</i>			
Bread	7.9/0.2	12/0.2	0.019/0
Candy	139/3.5	72/1	3.4/2.8
Coffee	310/7.8	422/6	38/32.1
Ice cream	79/2	20/0.3	0.506/0.4
Juice	47/1.2	39/0.6	19/15.4
Oat flakes	18/0.4	29/0.4	0.062/0.1
Oat milk	28/0.7	28/0.4	11/9
Pasta	36/0.9	52/0.7	0.099/0.1
Peanuts	104/2.6	110/1.6	15/12.1
Potato chips	26/0.7	24/0.3	0.361/0.3
Rice	184/4.6	51/0.7	7.9/6.6
Sparkling water	60/1.5	13/0.2	0.853/0.7

C

Hypothesis tests

This appendix shows all detailed statistical hypothesis tests performed in SPSS during the study. The hypothesis test from Subsection 4.2.1 is presented below in Table C.1.

Table C.1: The hypothesis test summary shows that there are significant differences between the genders' environmental impact from their OMP when looking at the parameters CO₂ emissions and water use. There are no significant differences between the environmental impacts from the genders' TMP, or when looking at the land use. Asymptotic significance is displayed and a p-value of less than 0.05 is considered significant.

Null Hypothesis	Test	w-value	p-value	Decision
The distribution of TMP: CO ₂ emissions (%) is the same across categories of Gender.	Mann-Whitney U Test	346	0.649	Retain the null hypothesis.
The distribution of TMP: Land use (%) is the same across categories of Gender.	Mann-Whitney U Test	316	0.909	Retain the null hypothesis.
The distribution of TMP: Water use (%) is the same across categories of Gender.	Mann-Whitney U Test	376	0.384	Retain the null hypothesis.
The distribution of OMP: CO ₂ emissions (%) is the same across categories of Gender.	Mann-Whitney U Test	198.5	0.019	Reject the null hypothesis.
The distribution of OMP: Land use (%) is the same across categories of Gender.	Mann-Whitney U Test	266	0.258	Retain the null hypothesis.

C. Hypothesis tests

The distribution of OMP: Water use (%) is the same across categories of Gender.	Mann-Whitney U Test	159.5	0.002	Reject the null hypothesis.
---	---------------------	-------	-------	-----------------------------

The hypothesis test from Subsection 4.2.2 is presented below in Table C.2.

Table C.2: The hypothesis test summary shows that there are no significant differences between the five different age groups' (13-19, 20-29, 30-39, 40-49, and 50+) environmental impact on any of their plates. Asymptotic significance is displayed, a p-value of less than 0.05 is considered significant, and the K-value is adjusted for ties.

Null Hypothesis	Test	K-value	df	p-value	Decision
The distribution of TMP: CO ₂ emissions (%) is the same across categories of Age.	Kruskal-Wallis Test	1.159	4	0.885	Retain the null hypothesis.
The distribution of TMP: Land use (%) is the same across categories of Age.	Kruskal-Wallis Test	3.736	4	0.443	Retain the null hypothesis.
The distribution of TMP: Water use (%) is the same across categories of Age.	Kruskal-Wallis Test	6.934	4	0.139	Retain the null hypothesis.
The distribution of OMP: CO ₂ emissions (%) is the same across categories of Age.	Kruskal-Wallis Test	3.306	4	0.508	Retain the null hypothesis.
The distribution of OMP: Land use (%) is the same across categories of Age.	Kruskal-Wallis Test	7.602	4	0.107	Retain the null hypothesis.
The distribution of OMP: Water use (%) is the same across categories of Age.	Kruskal-Wallis Test	4.423	4	0.352	Retain the null hypothesis.

The hypothesis test from Subsection 4.2.3 is presented below in Table C.3.

Table C.3: The hypothesis test summary shows that there are significant differences between the educational groups' environmental impact from their TMP when looking at the parameter water use. There are no significant differences when looking at CO₂ emissions or land use, or when looking at environmental impacts from the educational groups' OMP. Asymptotic significance is displayed, a p-value of less than 0.05 is considered significant, and the K-value is adjusted for ties.

Null Hypothesis	Test	K-value	df	p-value	Decision
The distribution of TMP: CO ₂ emissions (%) is the same across categories of Education.	Kruskal-Wallis Test	4.812	4	0.307	Retain the null hypothesis.
The distribution of TMP: Land use (%) is the same across categories of Education.	Kruskal-Wallis Test	6.282	4	0.179	Retain the null hypothesis.
The distribution of TMP: Water use (%) is the same across categories of Education.	Kruskal-Wallis Test	9.598	4	0.048	Reject the null hypothesis.
The distribution of OMP: CO ₂ emissions (%) is the same across categories of Education.	Kruskal-Wallis Test	4.254	4	0.373	Retain the null hypothesis.
The distribution of OMP: Land use (%) is the same across categories of Education.	Kruskal-Wallis Test	5.361	4	0.252	Retain the null hypothesis.

C. Hypothesis tests

The distribution of OMP: Water use (%) is the same across categories of Education.	Kruskal-Wallis Test	2.538	4	0.638	Retain the null hypothesis.
--	---------------------	-------	---	-------	-----------------------------

The hypothesis tests from Subsection 4.3.3 and Subsection 4.3.7 are presented below in Table C.4 for the categorized genders, Table C.5 for the categorized ages and Table C.6 for the categorized educational levels.

Table C.4: The hypothesis test summary shows that there are no significant differences between the learning, the non-learning or the mislearning outcomes within the groups of gender. Asymptotic significance is displayed and a p-value of less than 0.05 is considered significant.

Null Hypothesis	Test	w-value	p-value	Decision
The distribution of Observed learning is the same across categories of Gender.	Mann-Whitney U Test	253	0.183	Retain the null hypothesis.
The distribution of Perceived learning is the same across categories of Gender.	Mann-Whitney U Test	250	0.169	Retain the null hypothesis.
The distribution of Interpretation problems of data visualization is the same across categories of Gender.	Mann-Whitney U Test	234	0.069	Retain the null hypothesis.
The distribution of Misconceptions of data visualization is the same across categories of Gender	Mann-Whitney U Test	330	0.787	Retain the null hypothesis.

Table C.5: The hypothesis test summary shows that there are no significant differences between the learning, non-learning or the mislearning outcome within the groups of age. Asymptotic significance is displayed, a p-value of less than 0.05 is considered significant, and the K-value is adjusted for ties.

Null Hypothesis	Test	K-value	df	p-value	Decision
-----------------	------	---------	----	---------	----------

The distribution of Observed learning is the same across categories of Age.	Kruskal-Wallis Test	5.229	4	0.265	Retain the null hypothesis.
The distribution of Perceived learning is the same across categories of Age.	Kruskal-Wallis Test	2.672	4	0.614	Retain the null hypothesis.
The distribution of Interpretation problems of data visualization is the same across categories of Age.	Kruskal-Wallis Test	3.824	4	0.43	Retain the null hypothesis.
The distribution of Misconceptions of data visualization is the same across categories of Age	Kruskal-Wallis Test	6.355	4	0.174	Retain the null hypothesis.

Table C.6: The hypothesis test summary shows that there are no significant differences between the learning, non-learning or the mislearning outcome within the groups of different educational levels. Asymptotic significance is displayed, a p-value of less than 0.05 is considered significant, and the K-value is adjusted for ties.

Null Hypothesis	Test	K-value	df	p-value	Decision
The distribution of Observed learning is the same across categories of Education.	Kruskal-Wallis Test	5.450	4	0.244	Retain the null hypothesis.
The distribution of Perceived learning is the same across categories of Education.	Kruskal-Wallis Test	2.526	4	0.64	Retain the null hypothesis.
The distribution of Interpretation problems of data visualization is the same across categories of Education.	Kruskal-Wallis Test	2.936	4	0.569	Retain the null hypothesis.
The distribution of Misconceptions of data visualization is the same across categories of Education.	Kruskal-Wallis Test	7.695	4	0.103	Retain the null hypothesis.

D

Transcripts

The Swedish citations for the examples in subsection 4.3.5 are presented below.

Examples of CE:

Jag tror nog fortfarande att osten är ganska bra. Vi får se vad, om vi lär oss någonting, kanske. Och så tar vi ett glas vatten! Här var kanske vatten, men det är kolsyrat vatten va? Jaja vi kör på det i alla fall. Vi får se om vi lär oss någonting. (ID nr. 32)

Tomat kan nog vara det, beroende på... Och äpple också ja. Smör hade man inte va? Ost... Så då. Hur illa är jag? Hahaha... (ID nr. 51)

Examples of RO:

Det beror, det beror på lite grand, eh, för om man tänker ur vattenförbrukningen då, om vi tar den, då är det den (*pekar på egna tallriken*) som är bra. Men, koldioxidutsläppen, då är det den (*pekar på optimala tallriken*) som är bra. Så... Det beror på vilket du fokuserar på, så... Ja precis. Och ja, jag kan tänka mig, båda är ju viktiga, men kanske koldioxidutsläppen är ju lite mer att man fokuserar där då istället. (ID nr. 9)

Jag tror rent klimatmässigt det bästa är att man, eh, alltså, gör så lite djurbaserade produkter så att säga som möjligt. Men det kan ju vara svårt att helt lämna dem ute, men, ja... (ID nr. 17)

Examples of AC:

Och då beror ju det, ja, apelsinen till exempel, eh, att det går åt mycket vatten till det, eh, för odlingen liksom, i länder som, där de, man kanske inte har så, alltså, där det blir ett problem med vattentillgång. Men även att kanske mejeriprodukter då, att det går, att det går väldigt mycket vatten till det. (ID nr. 8)

Oavsett vad man lägger på så tar det ändå ganska mycket liksom, på, alltså... På vatten och, och koldioxidutsläpp och sånt. Även om man liksom typ tar, typ havregryn och sånt, det, ja det tänker man ju liksom

ska vara ganska så skonsamt, typ. Men det är ändå liksom, det blir ju ändå en påverkan. (ID nr. 10)

Examples of AE:

Jag tolkar ju absolut att jag, eh, istället för att äta yoghurt och eh, mjölk som eh, kommer från eh, ehm... Djurriket så att jag tar då havremjölk. (ID nr. 45)

Och så definitivt ehm, ska jag välja den (*pekar på optimala tallriken*) hehe, i framtiden, eh, över den här (*pekar på egna tallriken*) bara på grund av såna, eh, ja, e-, e-, e-, e-, dat-, eller information som jag fick. Mm, mm. [...] Och, eh, kanske, eh, ändra lite några grejer och eh, ehm... Kanske, eh, inrikta mig mer till, eh, natu-, ja, eller natur, jag menar grö-, grönsaker, grönsaker och frukt, kanske. Ja, e-, jag äter in-, inte ändå så mycket kött men ehm, ja kanske man kan minska det ändå, hehe. Ja, mm. Ja. (ID nr. 38)

The Swedish citations for the examples in subsection 4.3.4 are presented below.

Example - Support or expand an already existing point of view:

Jag visste faktiskt att skinka eller att kött är dåligt för klimatet men jag visste inte hur mycket det var, såsom jag ser nu på procenten... [...] Jag blev nog lite överraskad hur det verkligen ser ut, om det spelar så stor roll eller inte, men jag ser nu att det spelar ju väldigt mycket roll om man äter mer kött. (ID nr. 38)

Example - Establish a new point of view:

Det (*pekar på trädikonen*) är ny för mig... Koldioxid och vattenförbrukning har man ju ändå hört ganska mycket utav, men just markanvändnings aspekten har inte jag tänkt på innan. (ID nr. 57)

Example - Transformation of a point of view:

Jag tycker ändå den (*pekar på egna tallriken*) ser bra ut för klimatet. Alltså vattenförbrukningen är ju inte bra. Dåligt att det går åt mycket vatten där (*pekar på egna tallriken*). Däremot markanvändning... växthusgaser... [...] Det känns inte som det var jättebra, det var inte jättebra för klimat den här frukosten (*pekar på egna tallriken*). (ID nr. 54)

The Swedish citations for the examples in subsection 4.3.6 are presented below.

Examples - Misunderstandings and uncertainty:

Jag vet faktiskt inte hur man ska tolka de här, men 0%, alltså de-, det här måste ju ha med... [...] Men jag vet inte vad det är procent av vadå, faktiskt. Alltså, det vet jag inte. Eh... Nej, det vet jag faktiskt inte. [...] Tycker det är lite märkligt, alltså, om det här ska vara nån slags information om detta är bra eller dåligt, då hade man nog velat ha lit-, alltså jag vet inte... Procenten (*pekar på optimala tallrikens droppikon*), det blir liksom ingenting som blir... För att uppnå den föreslagna av vattenförbrukning krävs ett värde som är mindre än 328 liter. Mm. Men vadå, två procent, liksom? (ID nr. 33)

Ska vi se här... 52 procent av den föreslagna budgeten för vattenförbrukning. Är det på en hel dag då, eller på detta målet? (*pekar på egna diagrammet*) Kaffe, oj det går åt jättemycket kaffe! Mm. Den skinkan och, banan... Och så ost... Nej men jag... Ska vi se på den (*pekar på optimala droppikonen*) då... För att uppnå de föreslagna målen för vattenförbruk- krävs ett värde som är, mindre... Nä ja, men alltså, jag fattar bara inte om detta är på, är detta per måltid, detta är, eller, den här vattenförbrukningen? Eller är det per en hel dag? (ID nr. 44)

De blir ju inte lika långa (*staplarna i diagrammet*), varför blir de inte det? [...] Ja då hjälpte det ju inte så som jag tänkte, för jag tänkte att om allting är samma, så blir staplarna lika långa. (ID nr. 54)

Examples - Misconception:

Och då är det ganska liten yta som används för det här, jag skulle kunna ta fem sådana portioner i jämförelse med det som finns här. Så att det här är ju liksom, en ganska bra tallrik där man skulle kunna liksom, ta det gånger tre, kanske. Öka på med en biff eller någonting, inte vet jag... [...] Här, där ser ju ut att vara ganska bra (*kollar på ikonerna*). Eller 102 procent, jo... Jo, men det funkar. Ja men det där, sådär skulle jag ju kunna käka också... (ID nr. 37)

Så egentligen handlar det om världsdelarna och vad man äter där kanske? (*trycker på symbolen i mitten av bordet, inget händer*) (ID nr. 51)

DEPARTMENT OF COMMUNICATION AND LEARNING IN SCIENCE
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se



CHALMERS
UNIVERSITY OF TECHNOLOGY