

Data Bricks Space Mission

- Supporting Teachers for Children's Data Literacy in
Primary Schools through Data Physicalization

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Abstract

This thesis presents “Data bricks space mission” a toolkit for children that allows them to gather a dataset of information in an engaging and interesting way. The kit is made up of elements that give the opportunity of a first approach to the data physicalization process, breaking down barriers related to knowledge and experience in the field. The experience is completed by a guided activity that, through a role play, inserts the theme of the data collection in the school curriculum.

The study is based on the analysis of similar previous examples and the collection of information through interviews with instructors who work daily with children. Based on the insights of those theoretical and empirical foundations, a possible solution is presented that addresses the research questions.

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1. Introduction

1.1 BACKGROUND MOTIVATION

As a person born at the end of the 20th century, all my life I have been accustomed to an important presence of technology in everyday routine. For passion then, I found myself working more and more in contact with the internet, social media, and the digital world in general. Only recently, with the academic experience and the widening of the issues related to data generated by digitization, I began to understand how important it is to understand and manage the presence of data in our lives.

Nowadays individuals are subjected to an information overload on a daily basis, therefore there is a need for clear and insightful communication and data literacy among non-experts. Society and the economy are increasingly data-driven and each individual produces data every day, so people need to be aware of the importance and presence of these data. I believe that the average internet users are still too little aware of how the data they produce are collected and exploited and indeed do not realize the amount of information they absorb every day and how much they themselves are part of this phenomenon. Fortunately, an aid, in order to stem this issue, comes from information visualization, which is becoming more widely available through various media but still needs a broad education for consumers.

As a part of the process, it is important to educate that the collection of data is not only meant for professional purposes but rather could concern our everyday life as well. The word "data" often suggests something complex and abstract, difficult to understand in practice and it is almost complicated to provide a unique definition. On the other hand, research is increasingly moving towards a more human point of view towards data, which is not only about cold rational numbers but is rather generated, manipulated, and read by people and therefore represents a much more complex human phenomenon. In order to provide a more concrete experience of data in everyday life, different automatic tools already provide self-tracking, analysis, and representation of data, like running or biking apps. However, those tools are just a tiny part of the possible solution, since I think they still have some issues: on one hand, a lack of knowledge on the users' side can potentially lead to inappropriate use or wrong insights; on the other hand, commercial apps and trackers are often not flexible enough and therefore do not reflect the real users' needs.

In order to tackle a matter of literacy and knowledge, who is the data consumer who probably has very little, if any, knowledge about it? who can benefit most from such a solution? The answer is perhaps predictable, but it was the main direction for this project: children. In primary schools, we are taught language, mathematics, and science, which we then discover as adults constitute and represent everything that surrounds us. For this reason, and for the fact that it is now such an important issue, I believe it would be interesting and useful to include data education, what they mean and how we can use them, in the school curriculum. In the specific, this project aims to investigate the employment of data collection with children, who probably have not had the chance yet to achieve the right knowledge on the subject.

1.2 RESEARCH QUESTIONS

The purpose of this study is to contribute knowledge about data collection as a tool for learning, investigating, and reflecting on more or less personal data:

- How is it possible to design a tool or an activity for children that could lead them to understand the presence and the importance of data in their everyday life?
- How should it be built? How should it work? How is it interesting for the target?

1.3 CONTEXT

Since the project was developed in Sweden, it is designed to work in relation to the Swedish education system. In particular, the target audience is teachers and educators who work with children between 10 and 12 years old (the reasons and further context are explained in detail in Chapter 6), who at that age attend the middle stage of the primary school, called *mellanstadiet*. Despite this, the theoretical framework on which it is based presents generic concepts that are not strictly related to a specific country, therefore it is likely that the project can work in the same way within the same context of a different country.

When the term “curriculum” is used throughout the thesis, it refers to the collection of courses and their contents that the school provides.

1.4 DELIMITATIONS

Given the limited time of the ‘Thesis’ realization, the project could not fully benefit from the ideal research path through a design process. At the beginning of the project, the original idea was to directly involve the children of some primary school classes. Unfortunately, in order to optimize the time, it was decided to involve teachers instead, to overcome the limits of permits due to the minor age and linguistic barriers (both the supervisor and I were not proficient enough with the Swedish language).

1.5 INCLUSIVITY

Throughout the text, in the case of the third person singular, the pronoun “they/them” is used, instead of “he/him” and “she/her” to be more inclusive and representative according to the APA style guidelines¹.

1. Singular “They”, APA Style, 2019. (apastyle.apa.org/style-grammar-guidelines/grammar/singular-they)

2. Theoretical framework

This chapter of the thesis presents the theory behind the project, introducing previous research and case studies. It starts from a broad concept of data visualization, explaining what it is and what are its purposes, ending with a focus on the relationship between children and data, going through personal data visualization and data physicalization as a technique of making data concrete and tangible for everyone.

2.1 DATA VISUALIZATION

Data visualization, also mentioned as information visualization, data viz, or data vis, is the main broad area of graphic design in which this project is situated. For the purpose of this project, the following definition from Andy Kirk (2016, p. 31) is borrowed: data visualization is “the representation and presentation of data to facilitate understanding”. Although an essential and simple definition, it is composed of the fundamental elements that make up this practice:

- **Data** have the core role in the design process, they are the raw material from which everything starts.
- The **representation** is the form in which the data are depicted, usually meaning the kind of chart and the visual solutions are employed to communicate in an effective way.
- The **presentation** refers to the other visible design choices that build the overall visualization structure, such as interactivity, color employment, and composition.
- The goal is to **facilitate understanding** (Figure 2.1), meaning the process of “perceiving, interpreting and comprehending” (Kirk, 2016).

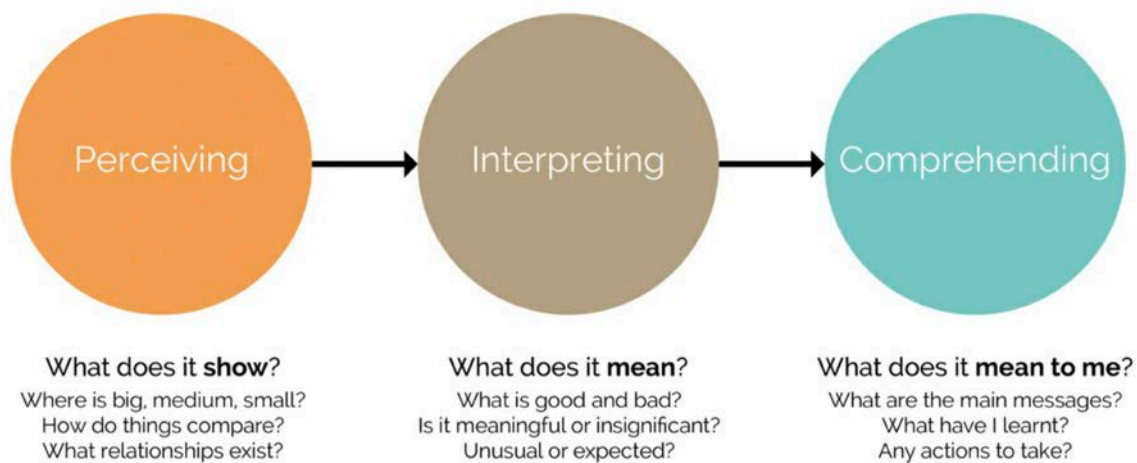


Figure 2.1: The Three Stages of Understanding (Kirk, 2016)

Illiinsky and Steele (2011) find four ways to classify different kinds of data visualizations: by complexity, distinguishing between data visualization and infographics, exploratory, and explanatory. The first option simply depends on the number of different dimensions it represents, meaning how many discrete kinds of information are encoded in the visualization. Secondly, they discern *data visualization*, usually computationally drawn, easy to regenerate with different data, and with a big amount of data, and *infographics*, generally manually drawn and visually rich, but poorer on the data side. Finally, there are two categories that differ in the purpose: exploration and explanation. In the first case, the data visualization is used to understand what is inside a data set, usually in the initial phase of the design. On the other hand, explanatory data visualization is commonly used when the content is already clear and is used to tell something to someone else, therefore is part of a presentation phase. Those last two categories are linked to the reasons why the presence of both humans and computers is always necessary for the data visualization design process (Munzner, 2014). If the research question is not perfectly clear, computational techniques, such as statistics and machine learning, are useful if the question is well defined. However, poorly specified problems are recurring because people are not often sure about how to approach that specific issue. For this reason, together with the computer, the human visual system properties are needed in the design, in order to detect a pattern where a computer might fail. On the other hand, computation allows exploring bigger datasets that would not be possible to be drawn by hand. Even if possible, a manual representation is limited to the person's abilities, the outcome is static and it requires a lot of time.

A key point in the design process of a visualization is to understand what the different types of data are. Kirk (2016) distinguishes data into qualitative and quantitative, specifically in textual, nominal, ordinal, interval, ratio, and temporal (Table 2.1). A different classification is proposed by Muzner (2014), who suggests dividing the data into attributes (also defined as variables or dimensions), items, links, positions, and grids (Table 2.2).

Table 2.1: The types of data identified by Kirk (2016)

GENERIC TYPE	SPECIFIC TYPE	PURPOSE
Qualitative	Textual	Unstructured stream of words
Qualitative	Nominal	Distinguishing, labelling, organizing
Qualitative	Ordinal	Ordering and classifying
Quantitative	Interval	Quantitative and numeric measurement on a scale
Quantitative	Ratio	Numeric measurements with properties of difference and scale
Qualitative/quantitative	Temporal	

Table 2.2: The types of data identified by Muzner (2014)

TYPE	PURPOSE
Attribute	Measuring, observing, logging
Item	Single discrete entity
Link	Relating in a network
Position	Locating in a 2D or 3D environment
Grid	Sampling continuous data

Moreover, data can be divided into discrete and continuous: the former corresponds to variables that have no middle states between them, while the latter has any middle value if the measurements make it possible (Kirk, 2016).

Different types of data need different representations in order to communicate effectively, and for this reason, there are more types of solutions between graphs and charts. First of all, it is necessary to make a first distinction between these two terms: while a graph is used to show quantitative information, a chart is usually indicated for qualitative information (Iliinsky, Steele, 2011). Kirk (2016) classifies the visualization in more detail into five categories:

- Categorical, to compare quantitative value categories and distributions.
- Hierarchical, to draw qualitative relationships and hierarchies between single elements and the whole.
- Relational, to discover correlations and connections by graphing relationships.
- Temporal, to show trends and activities over time.
- Spatial, to map patterns through overlays and distortions.

Each visualization has different graphic properties, which represent data and can be manipulated to achieve more effective communication. As proposed in Figure 2.1, the first stage of understanding is *perceiving*, meaning that the viewer has to *decode* different visual aspects presented in the visualization. On the other hand, the role of the designer is to *encode* data values into such aspects. Those properties can be divided into *marks* and *attributes* (Kirk, 2016), or *marks* and *channels* (Munzner, 2014): a mark is a visible quality, geometric primitives such as lines, dots, or areas, that can represent a record of data (Figure 2.2), while an attribute (or channel) controls the appearance of marks through size, position, color and represents a different quantity or category (Figure 2.3). The designer's role when creating a visualization is to find the right combination of visual elements that can effectively convey data, depending also on the purpose. As in design in general, in

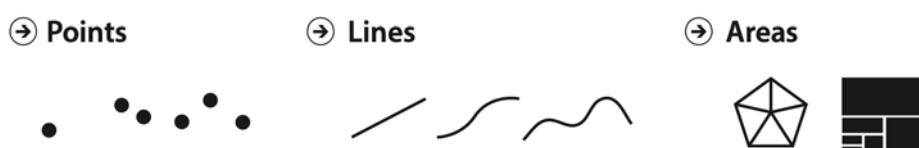


Figure 2.2: Marks are geometric primitives (Muzner, 2014)

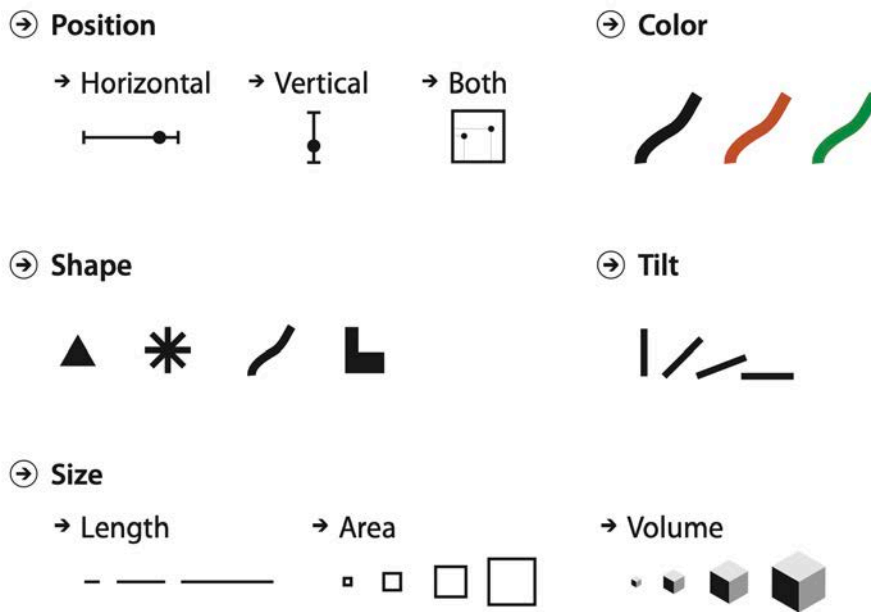


Figure 2.3: Visual channels control the appearance of marks (Muzner, 2014)

graphic representation, aesthetics and functionality must be integrated, highlighting insights, relationships, and key aspects in an intuitive way.

If all of these aspects have been coded effectively, data visualization can be used in different domains with several advantages. Munzner (2014) considers external representation as a human capacity augmentation: it is a tool to overcome cognitive and memory limitations. It enables to unload the mind by using visuals as external representation in different forms. Externalizing the memory gives the possibility to organize information, facilitating the processes of research and recognition. Moreover, nowadays society relies on the promise of better decision-making through access to more data than ever before and people can use data visualization to evaluate data when they do not know what questions to ask ahead of time. Iliinsky and Steele (2011) similarly state that data viz uses the extraordinary capabilities and capacity of the visual system to rapidly transmit a large quantity of information into the brain, identifying patterns, relationships, and meaning. In doing so, it can spark new ideas and prompt additional investigation to identify problems and eventual solution paths.

2.2 PERSONAL DATA VISUALIZATION

With the development of technology in recent years, more and more people are collecting massive volumes of data on their daily lives. Personal visualizations have the potential to bring the advantages of visualization to everyone in their daily life (Thudt et al., 2017). When the personal visualization is created by the people themselves, they may adapt it by incorporating it into their personal contexts, prompting moments of reflection and debate. Ching and Wang trace these practices back to what Foucault calls "technologies of the self", referring to "conceptual tools and practices that aid self-cultivation or self-evaluation" (2012).

Huang et al. (2014) investigated how to empower people to become aware of, explore, and learn from data in a personal environment. People are already envisioning their everyday routines but little is known about whether these initiatives are successful, how they might be improved, and how they will affect people's lives. Society has now immense opportunity to use this data to better understand ourselves and create positive changes in our lives.

By presenting DataSelfie, Kim et al. (2019) discuss how personal informatics technologies enable people to gather and manage personal data while also reflecting more deeply on themselves, but they seldom allow users to personalize how the data are displayed.

2.3 DATA PHYSICALIZATION

The project's core concept is built around the idea of representing information with physical elements in order to make data more tangible and understandable despite their abstract essence. In parallel with the concept of data visualization, Jansen et al. (Jansen et al., 2015) define a data physicalization as a "physical artifact whose geometry or material properties encode data", presenting the two main aspects of it: it needs to be something material and concrete, and that something must embody some sort of data.

Dragicevic et al. (Dragicevic et al., 2021) provide a complete overview of how the concept of data physicalization has been used over the years and what different applications it has had. For example, since the 19th century, several scientists took advantage of 3d solid models for analytics and communication: the physicist James Maxwell built plaster models of three-dimensional thermodynamic functions that assisted in the development of the thermodynamic theory of the state. Similarly, John Kendrew took advantage of the construction of solid 3D molecular models of the structure of myoglobin in 1958. On the other hand, a less pragmatic approach can be found when it comes to the use of data physicalization for self-reflection and expression and for meaning-making. The researchers found that translating data into tangible materials fosters the process of analyzing and improving oneself and one's habits, as well as a greater possibility of externalizing one's identity or thoughts to other people. They discuss current technologies, empirical studies, and models as well. Since the arrival of modern 2D media, either on paper or on screen, research has focused in that sense, not considering the use of physical data visualization despite being widely used previously and still having several advantages today. Moreover, modern technologies, like 3D printing, allow to create physicalizations that are faster and easier to produce and that can potentially be richer thanks to computation.

Huron et al. (Huron et al., 2014) discuss constructive visualization, a concept similar to data physicalization, but with a focus on how such practices offer the possibility of democratization of visualization, meaning that non-expert people can design their own visualizations. They present the necessary components to offer tools to people in order to achieve this goal:

- Token - which is the visualization's discrete basic unit, with different possible features such as color, shape, volume, material, etc.
- Token grammar - to define the set of different tokens and map their properties into aspects of data.

- Environment - meaning the space where tokens are settled and therefore the structure that set the boundaries of how tokens need to be assembled.
- Assembly model - that describes the construction process criteria.

They then move on to illustrate the ideal process to construct a physical visualization. It starts by choosing the environment and the related constraints and then mapping the data properties into the physical characteristics of the tokens. Then the actual construction begins by assembling the tokens within the environment, based on the token grammar. Eventually, the construction potentially goes under several updates that change the first assembled state.

Several activities and workshops have already been built on such ideas and have illustrated how physical visualizations can be used to author and interpret data representation, educate through playful activities, and foster reflections and discussion around different topics.

“Viskit” (Huron et al., 2016) offers the chance to perform a workshop heading towards engaging non-experts in the first experience with data representation. The authors present the kit components (tangible tiles of different colors) with their instructions, which should guide the audience in experimenting with writing, reading, and analyzing a visualization.

“Datablokken” (Verhaert et al., 2021) is a physicalization game with the aim of stimulating children’s literacy in social media data usage and investigating the didactic potential of playful data constructive visualization. The game challenges the target audience, nine to twelve years old children, in their understanding of the use of social networks and stimulates them to reflect on how best to manage their personal data.

In both their workshops, Thudt et al. (2018) and Huron et al. (2017) explored how the employment of physicalization can help in simplifying the process of reflections from data. In the first case, they involved non-experts in a 2-4 week activity in which they had to collect personal information and translate it into a physicalization. They verified that physicalization is successful in considering how personal data tracking is tangled with the real world. Moreover, several types of reflections can be related to the different steps of the process, from the preparation to the final construction. On the other hand, in the second case, the focus group consisted of professionals from different communities from Computer Interaction to Design and the focus was more on how setting constraints can on the one hand encourage involvement with physical materials, without thinking too much about research and preparation, and, on the other hand, leave enough space for creativity in a playful way.

Walny et al. (Walny et al., 2015) provide a slightly different idea based on data sketching rather than using physical artifacts. They analyze 35 sketches representing a small dataset and present the different results in “a visual representation continuum from numeracy to abstraction and a data report spectrum from statements about individual data values to conjectures and fledgling hypotheses” (Walny et al., 2015). As for physicalization, through sketches, it is possible to create metaphors with data that help the visualization and analysis of a more or less complex dataset. A clear example of this concept is the Dear Data project (2016) in which Lupi and Posavec present a collection of postcards exchanged between them and through which they shared visualizations of personal data that represented an aspect of their life in a week. Following up on this project, the

authors also presented a kit (Lupi, Posavec, 2016) that offers readers the opportunity to live the same experience, providing postcards with suggestions of topics already. With the same purpose, but through physicalization, Jose Duarte presents "The handmade visualization toolkit" (2011), containing a set of materials to easily create lo-fi visualizations.

All these publications, activities, and workshops demonstrate the potential that data physicalization has as a tool to support data literacy and introduce data collection, representation, and analysis to non-experts. Huron et al. (2014) state that it provides simplicity and accessibility in understanding abstract concepts, expressivity with a creative approach, and dynamism that offers the chance for updates over time. Moreover, making the data tangible leads to a more engaging experience with lower barriers for those who do not have enough knowledge on the subject (Huron et al., 2014; Huron et al., 2017; Thudt et al., 2018) and give the chance of working with personal information and therefore personal insights and reflections (Karyda et al., 2020; Thudt et al., 2018). In order to do so, also the gamification of the experience can be an important aid through the integration of playful elements into the school curriculum (Verhaert et al., 2021).

2.4 CHILDREN AND DATA

As data becomes more and more important within society, part of the research has begun to wonder how to introduce the subject to non-experts, including children and youths, to educate them in the world of data and give them the opportunity to start relating to it. Even though some literature aims to improve data literacy for children, it focuses on teaching data in a more scholastic sense, as part of mathematics or statistics. However, some aspects raised are noteworthy. English (2010) proposes data modeling, as a way to engage children in problem-solving, in order to introduce young learners to statistical activity. One point presented is particularly interesting: real life and the problems it presents can serve as the beginning point for learning with data, rather than any predetermined abstract model. Letting children work on things they know and experience every day is a great way to foster learning and engagement.

In two different papers, Oygür et al. (2020; 2021) focus on the use of wearable activity trackers by children and their families to analyze data on health. In addition to analyzing how the collection of personal health information is commonly used within the family, in both studies, there was a use of technology to collect data *on* children and not *by* children. Therefore the tools appear inappropriate and not tailored to the users, the children, who remain passive and do not have the opportunity to work and reflect on data.

In order to face the Covid-19 pandemic, Schwabish and Bowen (2022) present Data4Kid to help children's data literacy. The project consists of five "data stories", starter kits of three levels for different grades. Each kit includes a guide for the instructors with the learning goals and research questions for students, a dataset, a data dictionary with definitions, and slides with proposed questions for exploration and data visualizations.

More specifically, some studies have focused on data collection directly conducted by children. Compared to the previous examples, in these cases the child is placed at the center of the action, making them an active part of the process.

Hutchison et al. (2000) present a project with an interest in how children ask, collect and answer their own data-driven questions and in the insights gained by the adults compared to their first assumptions. They found an important barrier in finding the subject of the questions: the issues proposed were uninteresting for children because they were too "adult" and the students' first proposals were related to factual problems that did not require data collection. Even though many questions could still be answered with simple information or merely by counting. Furthermore, once data collection on pen and paper began, some students found themselves having to adapt their process, highlighting that it was possible to learn by doing and that a fairly flexible system was needed. Finally, to ensure that the activity is fruitful, the authors specify that it is useful to provide a large amount of data "to extend their problem-solving abilities" (Hutchison et al., 2000, p. 218) and that the teachers engage in the role of facilitators, asking questions and addressing students.

Stornaiuolo (2020) worked with teenagers in order to reframe their role as passive data producers and consumers into data agents who can curate, collect, and visualize their own personal data stories. The author states that data literacy education can enable youths to critically reflect on data usage and identify themselves as data rights holders. What this project does is carry out an intervention that changes the norms that lead to situated, ideological, and racialized data empowering youth from non-dominant communities as creators, designers, and authors. This is due to the fact that information is not true and objective, but rather physically and temporally generated with assumptions and ideologies. Finally, when it comes to the design process itself, it is interesting to note that it was difficult for the students to find a topic because it was not clear from the beginning what was meant by data and they simply attributed the concept to something "countable".

Although it drifts apart from the concept of data used up to now in this text, photographs can also be considered as artifacts that convey information. Ching and Wang (2012) employed the photo journal technique to let the children tell stories of their experiences at school. The self-representation in the pictures was for the kids a way to cope with new situations in terms of past experiences and provided tools to plan the future. *Constructionism* was an essential part of the experience because learning occurs most effectively when students are involved in the creation of meaningful objects to share with others. From the outputs of this activity, the authors noted that children tend to focus on their favorite activities and to include their closest friends in the narrative. Moreover, the creation of the artifact for its own sake is not enough, it is essential that children elaborate on the results. In order to do so, as already highlighted by Hutchison et al. (2000) above, follow-up questions from instructors are crucial to help the children elaborate.

Finally, introducing data collection to children can become an act of democratization, meaning that it allows them to participate in researching and presenting the obstacles that they experience, as well as influencing decision-making processes concerning children's issues. To meet these needs, Save the Children Sweden (Esterhuizen, 2012) published a guide as a part of the project "A Civil Society for Children's Rights in the MENA Region". Their goal is to empower children in collecting information about their lives and in informing people about their reality.

3. Method

This chapter describes how the design process took shape through concept development. It starts from the explanation of the concepts of research through design and double diamond and then explains in detail the practices of desk research, mind mapping, and semi-structured interviews used in the project

3.1 RESEARCH THROUGH DESIGN

The research course of this project follows the concept of Research Through Design (RtD), meaning the production of knowledge by creating a real and feasible solution to a problem (Stappers, Giaccardi, 2017). Unlike established scientific research, RtD draws on the design's feature of being a reflective activity, constantly reinterpreting and reframing a problem or a situation through the creation and critique of artifacts that serve as potential solutions. From this process, knowledge can come out in different aspects: the features and technologies of the prototype created, the functionalities it presents and how they interact with people, the type of audience it addresses, and the design process itself that led to that result. Following the two research questions, the intention of the project presented in this text is to produce knowledge in two directions. The first comes from the design process that led to the final concept, what were the design choices, and if and how they were effective. This is done by presenting the design methods that have been adopted and analyzing the benefits they have brought to this project. The second one is made up of the characteristics of the prototype itself, of how they constitute a solution to the issue presented at the beginning of the project. In the conclusion of this paper a possible solution, consisting of physical materials and a related activity, is presented and has the purpose of being a starting point for discussion for research in this area. As explained in Chapter 8 it provides an answer to the second research question, but it is deliberately a solution open to possible improvements and modifications through testing with different actors and further prototyping.

3.2 THE DOUBLE DIAMOND MODEL

Drawing on the Double Diamond model (Design Council, 2005), the design process employed is based on a series of converging and diverging phases: Discover, Define, Develop and Deliver (Figure 3.1). The Discover stage's goal is to serve as divergent thinking in which the designer maintains open perspectives in order to produce a diverse variety of ideas and inspirations. By analyzing previous information in the field, such as data, trends, literature, and other projects, the goal is to raise a question, suggest a hypothesis, or define a problem. In this project, this phase starts from the generation of ideas based on literature and previous examples to explore the environment in which the project is settled. In the Define step, a sort of filter is applied to previous findings: concepts are reviewed, selected, and discarded. The results from the Discover stage are analyzed, defined, and refined as issues, and solution ideas are proposed and prototyped at this step, in order to try to foresee the possible scenarios. The Develop stage refines the concepts to meet the challenges or

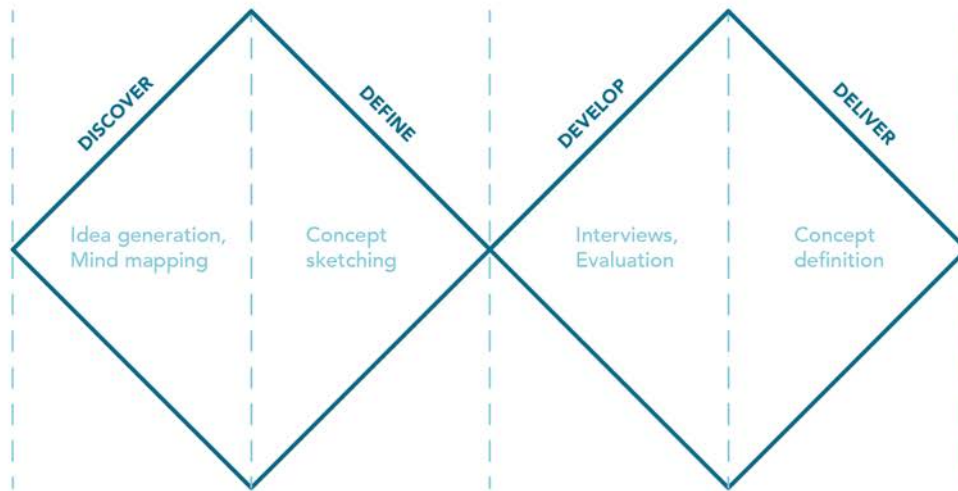


Figure 3.1: The Double Diamond model applied to the project, adapted from *What is the framework for innovation? Design Council's evolved Double Diamond* (2015)

problems identified in the Discover and Define stages. Design development methods used in this step include brainstorming, visualization, prototyping, testing, and scenarios. The methodologies and working procedures are often identical to those employed during the Define stage, but at this stage, they are focused on delivering the agreed-upon product or service. For this project, a further step into the idea development is done through interviews with experts to get feedback on the first ideas and provoke insights that can enrich the concepts. Finally, the Deliver stage produces a product or service that effectively solves the problem discovered during the Discover stage. It also contains mechanisms for feeding back lessons from the whole design process, as well as procedures, ways of working, and pertinent information, to educate future initiatives. It takes shape in the final concept, where the knowledge from the literature and the insights from the interviews are combined into a unique product that gathers all the findings of the design process.

Moreover, the Design Council (Design Council, 2015) states four fundamental principles that designers should follow in order to create something efficient and feasible:

- Learning about people, putting the focus on the individuals who use a service, their needs, strengths, and goals.
- Striving for a common understanding of the problem and its solutions.
- Collaborating with different professional figures and being motivated by others' efforts.
- Iterating and repeating the process to catch problems early, prevent risk, and gain confidence in ideas.

All these principles have been adopted in the project, with the exception of the last one, the iteration. Due to time constraints, only one process loop could be carried out. Potential developments resulting from further iterations are discussed in Chapter 8.

3.3 DESK RESEARCH

The project started with a rather generic research question, as a result of academic interest in the topic of data visualization. As a first step of the design process, solid research is crucial to understand and build the framework in which the project is situated. Starting from the initial research question, the desk research or secondary research is useful to define a more specific and significant topic on which to conduct research. The original question might be redefined with different details or be replaced with a completely new one based on the findings. Specifically, in the first phase of this project, it made it possible to move from the generic topic of data visualization to the more specific one of data physicalization in relation to children's education. As explained later in Chapter 4, through the analysis of data physicalization and personal data physicalization papers, a niche was found on which the research had not yet fully focused.

Secondary research involves pre-existing studies and examples published in commercial and academic books or papers. This provides the opportunity to learn from others' knowledge and therefore to understand where to focus in order to achieve interesting findings for the research itself. On the other hand, it enables the collection of insights that may be translated into key concepts for the project that is going to be designed. Travis and Hodgson (2019) provide three main points for which desk research is essential at the beginning of a design project: you need to know what has been done before to make sure you are doing something new, it provides credibility and reliability to the project and it helps to optimize the time when looking for more detailed information, perhaps with interviews. The goal at the end of the research is to have a good basis and a path to follow for the ideation phase of the project.

3.4 MIND MAPPING

The second step consists of translating all the information from the literature and the insights from the interviews into a multitude of ideas that might take shape in the solution of the addressed issue. Although brainstorming exercises are most commonly utilized in groups, where the interchange of views between people fosters the generation of new ideas, they may also be used individually to elaborate equally interesting ideas. In order to do so, mind mapping has been applied to this project as a solution to organize random ideas that come from different sources and find new ones. By placing the main subject at the center of the map, we proceed by adding all around the concepts connected to it. This process can be repeated for each smaller concept, up to the desired level of detail. A more logical sense is given by the use of graphic elements, such as colors and shapes that enrich the hierarchy of the map. Depending on the medium adopted, there is also a certain level of possible dynamism that allows for reorganization of the structure of the map if needed. This practice allows to take apparently unrelated concepts or information that have been explored at different times and to give them a logical order by finding connections and points in common and facilitating useful insights.

Throughout the project, it was applied in three different moments. First, to organize and give a logical order to the reference literature. Through an online board on Miro, it was possible to divide the papers into generic

categories and create links between them with specific common themes. It was then used in two different ways in the idea generation phase. In the first place to gather and organize the different ideas obtained from the literature research: they were arranged in a bubble map in which a first level of detail expressed the generic concepts, while a further level went into the detail of the questions that should have had an answer during the development phase. A final mind map was created to organize these insights more specifically and translate them into possible ideas based on the dichotomies they generated, as better illustrated in Chapter 5. Finally, the same process was adopted to organize the insights obtained from the interviews, with different graphic levels to encode characteristics and hierarchies.

3.5 SEMI-STRUCTURED INTERVIEWS

In order for those ideas to make sense in the real world, it is necessary to engage with the people who will be directly involved in the final artifact. This point can be fulfilled through different collaborative design activities, which vary according to the desired objective and the phase of the project in which they are adopted. Specifically, semi-structured interviews with the target audience were used in this project. Steve Portigal (2013) states four main steps of interviewing:

- Analyzing the audience in-depth, ideally in the context in which the project is settled.
- Investigating their behaviors and understanding the relative relevance.
- Analyzing and interpreting the gathered information.
- Merge the findings into the design process.

In this project case, the main purpose of interviewing is to verify and reframe the initial problems and ideas developed in the first stages. It is useful to understand what can work and what can not in the concept that is being designed, in other words “where (and why) your solutions will likely fail and where they will hopefully succeed” (Portigal, 2013, p. 28). The fact that the interview is “semi-structured” defines the intent of the activity: statistical and objective answers are not sought to a specific list of questions, but rather an attempt is made to stimulate a discussion that produces unique and qualitative knowledge.

For this project, only one round of interviews with three actors of the potential audience was applied due to time constraints. Nevertheless, it is the fulcrum on which this research is based when it comes to involving external people in the design process, as explained in Chapter 6. It helped to verify the knowledge gained from the literature and to obtain new ideas for the development of the project.

4. Desk research

This chapter presents the first step of the project: the development of the desk research starting from a broad topic and getting to a more specific one through literature review. It also explains how this process has been mapped on an online board and how the design process has benefitted from this practice.

4.1 TOPIC DEFINITION AND MAPPING

The subject of this project finds its foundations in a purely personal interest developed in the academic field for the topic of data visualization and the desire to make it more accessible to common people, despite being commonly considered reserved for academic research. The research phase started with a rather broad question: how could information design practices lead to more chances of personal insights and self-reflection or group discussion for non-professionals? The goal from the beginning was to refine the research question through the design process itself, deepening the literature and obtaining more information through interviews with the target audience that would be defined along the way. The concept behind the initial research was to answer this problem through the physicalization of the data by creating a toolkit that would facilitate this practice for non-experts. This outlines the first two areas on which desk research has focused: data physicalization and personal information. In parallel, both fields were explored through divergence. Starting from the most important papers found through Google Scholar, Research Gate, and online library resources, an in-depth study was carried out in two directions: towards the references listed by each paper, and toward other articles that cited each publication. In this way, a network of references was created, sometimes linked toge-

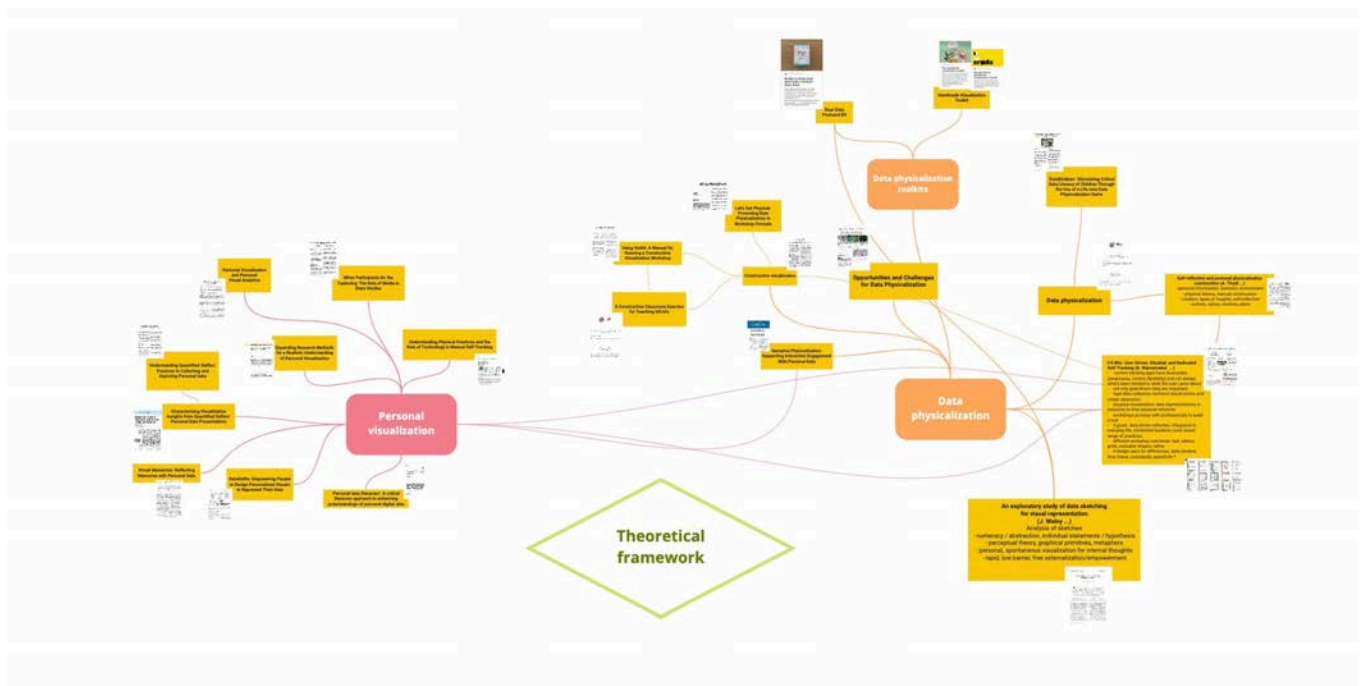


Figure 4.1: The online board on Miro after the first round of desk research, summarizing the literature in personal information and data physicalization.

ther by shared concepts supporting the project under development. In particular, some key aspects emerged, presented in Chapter 2, that have been then developed as the foundation of the interviews and the final concept. In order to keep track of this network, a Miro board has been used (Figure 4.1), which shows all the titles, authors, and links to the PDF files saved on Google Drive for each paper. This way of mapping resources has allowed the creation of a mind map with logical groupings and connections that allows easier fruition. The design process benefited from this phase because it favored the identification of insights and ideas and it was possible to more easily recover concepts throughout the development of the project.

4.2 FIRST LITERATURE REVIEW

The analysis of the data physicalization and personal data visualization literature outlined the first direction of the project but it was still rather broad and indefinite, so it was necessary to take a more specific path. In most of the studies, the people involved had a more or less good level of knowledge in the field of data visualization: in some cases, they were professionals of the data viz academic network, while in others they were ordinary people with no particular experience. The latter, however, were always adults with a minimum knowledge or some preconceptions of what it meant to collect data, analyze it and display it through charts and graphs, mainly thanks to the knowledge brought by the experience at school. Although it is clearly interesting to study the application of advanced data visualization techniques in areas that do not normally exploit them, after a session of brainstorming the concern focused on an audience that had even less knowledge and skills: children. Previous studies have highlighted how important it is nowadays that everyone in society understands the importance that data are gaining and that everyone consumes and produces them in everyday life. Following this thinking, school is the natural place to learn basic knowledge about something that is becoming so important, like language, math, science, and so on.

4.3 DETAILED LITERATURE

Starting from a generic framework, it was necessary to go into a more detailed point of view and study the previously analyzed practices applied to childhood, and how they could be integrated into the school curriculum or transformed into an interesting activity for children. In this situation, the opposite strategy was applied: because of the specificity, it would not have been helpful to do divergent research, but rather a more focused one on the specific issue. However, that research highlighted a lack of specific literature, which is limited to a handful of articles found on Google Scholar and ResearchGate. Many studies focus on educating children to use data in a more mathematical and statistical sense, emphasizing the purely scientific application of these practices. On the contrary, the goal of this project is to provide a more human view that presents data as a positive and negative part of everyday life. Consequently, as presented in chapter 2, it was decided to focus on the first step of the stage, that of data collection, to underline the fact that when it comes to data, it is not just a matter of numerical information collected in tables, but rather a different language to express

the reality that surrounds us. The articles that were found present workshops conducted in schools, toolkits, and games to introduce the topic and support data literacy with children, introduced in more detail in Chapter 5. As in the previous literature, each reference was noted on Miro's online board, highlighting links with the previously explored studies of data physicalization and personal data visualization (Figure 4.2).

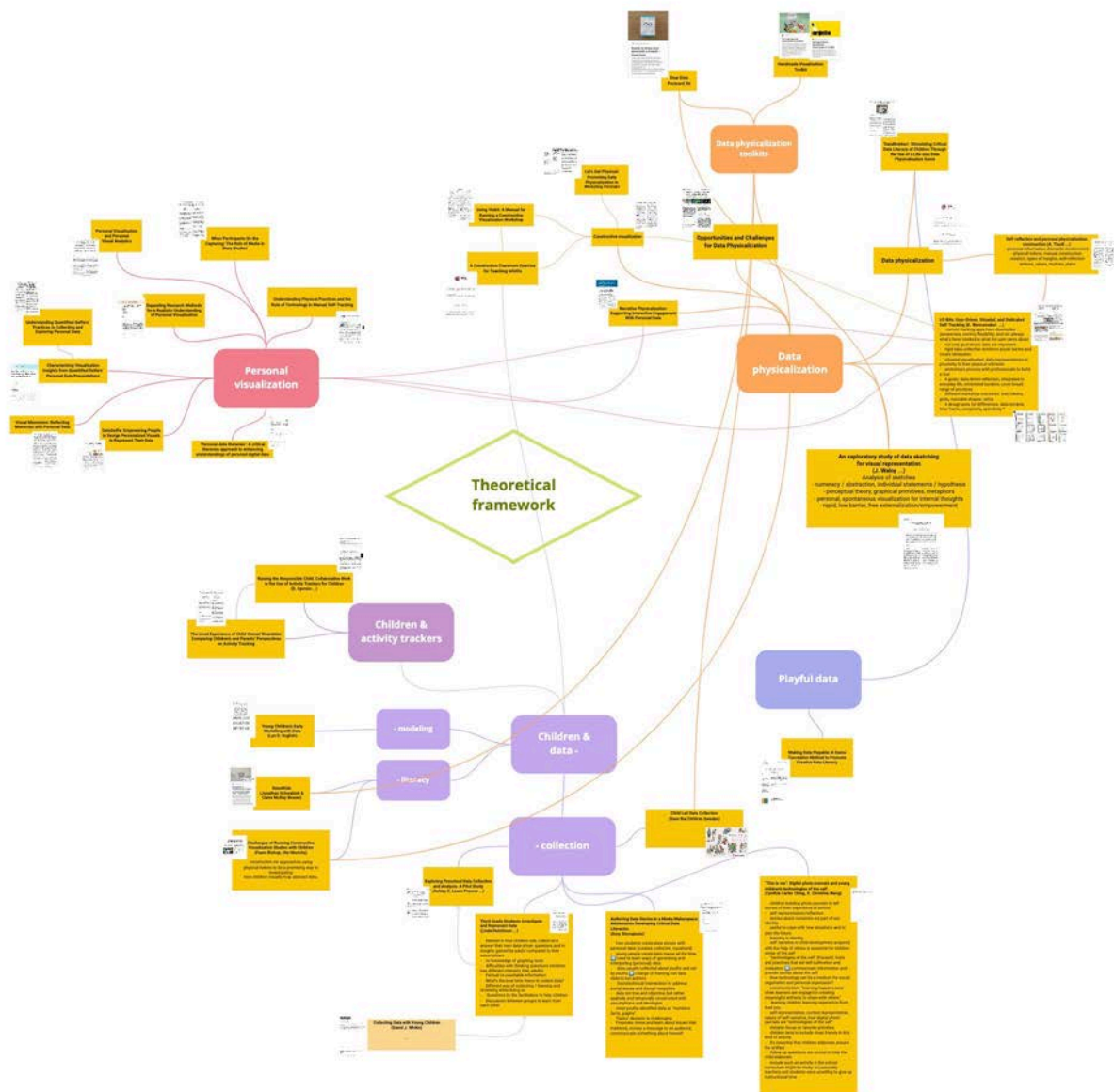


Figure 4.2: The online board on Miro after the second round of desk research, with the addition of the “children and data” area.

5. Idea generation

This chapter presents how knowledge and insights from the literature were gathered and then translated into the fundamental ideas that constitute the project.

5.1 LITERATURE INSPIRATION

At this point in the design process, the goal of the project and the expected outputs are defined, but there are many disorganized concepts that emerged from the literature and need to be combined and channeled into a solution. In order to organize and give a shape to these ideas, they are represented in a mind map with two levels of detail: the general concept involved and the more detailed issues in which it consists (Figure 5.1). The concepts that have emerged and that would have been developed along the design process are listed and explained below. In this phase, no solutions are presented but only issues that will be studied and solved for the final outcome, still being this a moment of exploration.

Components and information documents

These are the essential physical elements that make up the solution in terms of shapes, quantities, and materials. As mentioned in Chapter 2, they need to respond to qualities such as simplicity, expressiveness, and dynamism in such a way as to offer the most affordable and insightful experience possible. Based on the literature, such elements might be hand crafted starting from basic tools such as paper and scissors or could be already existing objects such as Lego bricks. The first option definitely leaves more space for creativity and therefore a more tailored solution. However, the second one requires less time and effort although keeping a good range of flexibility. Another option is to let the audience build them as part of the project itself, to let

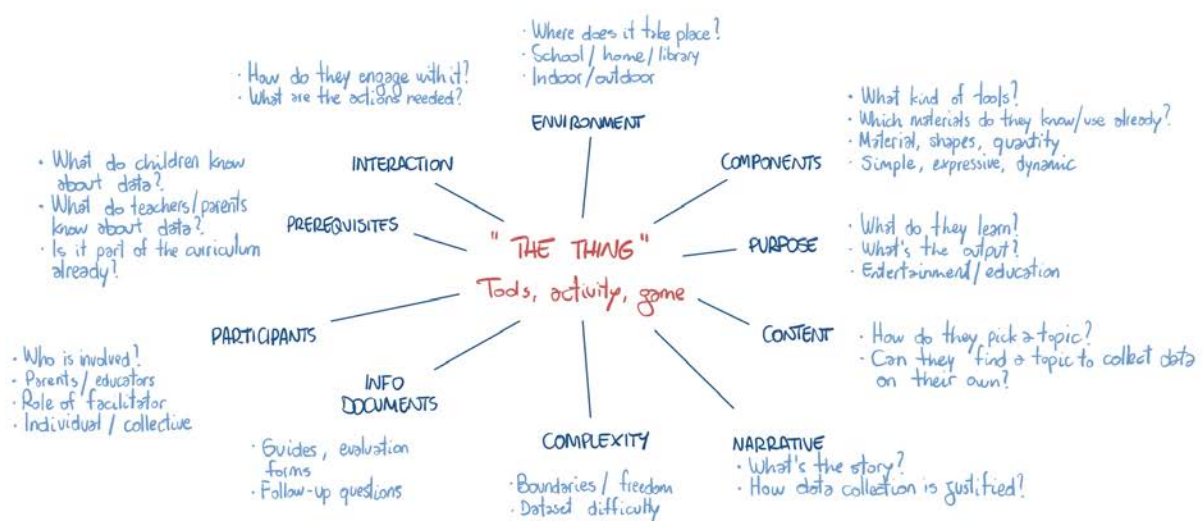


Figure 5.1: The mind map with the concept emerged from the literature. At the center is the project, which in this phase is considered potentially a set of tools, materials, guides, in the form of an activity or a game and is generically called "the thing".

them be even more familiar with the tools. In addition to the physical objects, there may also be written texts to support the activity, such as a guide or rules that help participants along the data collection process.

Environment

Is where the project is situated and takes place, the external elements that are not physically part of the artifact but that will influence the experience. For this project, the most suitable solutions are the spaces that children habitually frequent, first of all, the home and the school, but also recreational places such as youth centers.

Purpose

What is the outcome of this activity? What do children take with them once it is over? As highlighted previously, the general goal is still to foster data literacy in children, but the solutions may be different. The activity can have a more entertaining spirit, like a game, or it can be part of a lesson at school, with a more educational purpose. Knowledge can come either in the form of experience or in the form of theoretical notions.

Content and narrative

Data collection can concern different topics, potentially related to the personal sphere of children or a topic dealt with at school, in one or more different subjects. It is also possible that the topic is chosen by the children themselves or provided by educators as part of the curriculum. In addition, the method and the form in which this content is conveyed and told can vary. It can involve more or less engagement by children, as in the case of a role play, and it determines the reason for which the data collection is justified.

Prerequisites

It is what the participants, both children, and educators, should know or possess in advance to be ready for the activity. Too stringent requirements can pose too high a barrier that would undermine the affordability of the experience. Consequently, it is necessary to understand what the average preparation of the participants is, in order to build an activity as tailor-made as possible, first of all with regard to data.

Complexity

It is closely related to what has been said about prerequisites, but it focuses more on the possible barriers that can arise during the activity. For example, it is necessary to understand what is the children's previous knowledge, to not make them work with a dataset that is too complicated and goes beyond their abilities. To do this, the right balance must be found between freedom of action and the boundaries provided, which, even if limiting, act as a guide.

Participants

They are all the actors involved in the experience and it is not limited to just children. As already mentioned, the presence of a facilitator is useful, a role that can be carried out by parents or educators and for which it is

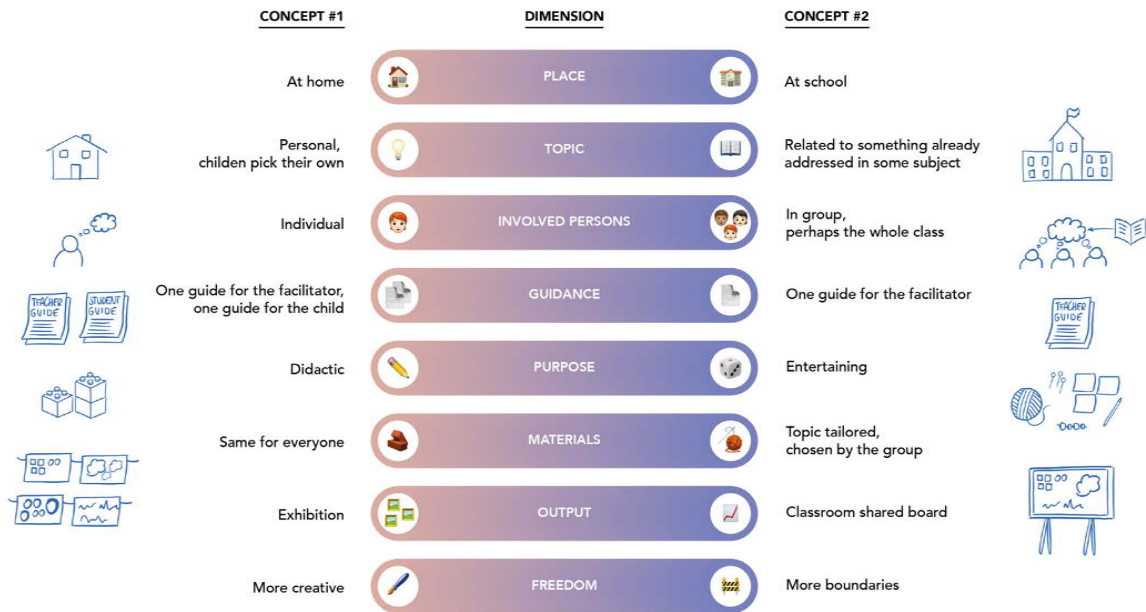


Figure 5.2: The list of dimensions that builds up the two concepts base on the dichotomies.

necessary to define the tasks and the area of action. Furthermore, the activity could be carried out either individually by each child, or collectively as class work, or divided into smaller groups.

5.2 BUILDING ON DICHOTOMIES

In preparation for the interviews (discussed in the next chapter), an additional level of detail was required in elaborating the literature insights. This is because they appeared in a still generic and relatively disorganized list that did not allow easy understanding from the outside. Many of the concepts presented proved suitable to be represented as *dimensions* placed between two *extremes*, two possible different solutions that eventually would characterize the project. A list of *dichotomies* was thus created from the previous concepts, features that were adaptable according to what would be the most suitable solution (Figure 5.2). By placing these characteristics at the center of a visual system, the structure of two potential solutions is naturally outlined on the sides. Despite this, the goal is not to already build a final artifact, but to translate concepts into more realistic and concrete considerations to facilitate understanding. As shown in the figure below, the dimensions taken into consideration are materials, place, output, participants, topic, purpose, guidance, and freedom.

The two resulting concepts are as follows:

- Concept #1: it consists of a set of tools and related activities, thought to be carried out at children's homes. When they get back home from school, it is supposed to be like homework for them. There are a couple of

guides, one for the teacher and one for the children: the former to help children through the process, to be the facilitator of the activity, and the latter to make up for the lack of a facilitator at home, so that children do not get lost in something that they might not know. It is an individual activity, in such a way that each child chooses a topic that they like. The material is the same for everyone and as a result, the effort of creating something out of scratch is reduced. For example, it could be Lego bricks, because everyone knows them and is familiar with them. At the end of the process, an exhibition in the classroom is supposed to take place, where kids can explain what they have been collecting data on, what is the story behind it, and what they wanted to say or explore with the data collection.

- Concept #2: as the first one, it is an activity to be carried out with a set of tools, but in this case, it is taking place in schools, in the classroom. It is a group activity, they are supposed to do it as a class or as smaller groups within the class. They can take decisions together, as a whole class, but they still have the guidance of the teacher. For this reason, the teacher still has a guide to help children through the whole process. So the teacher knows what to do and what is the next step of the activity. It can be related to a topic that it has been touched in the curriculum in school, eventually some specific subjects. It can take the form of a group game in order to provide more engagement. The materials are tailored for the single project so that children get to pick specific materials for a specific purpose. As in the previous one, at the end of the activity, participants gather around to discuss but with a shared board in the classroom, probably the same that they have been working with for the whole process.

6. Interviews

In this chapter a nerve center of the project is explained, the interviews with the teachers. It presents the process by which the interviews were studied and conducted and comes to summarize the results obtained.

6.1 PURPOSE AND STRUCTURE

After having explored the concepts derived from the literature, it was necessary to transpose them into the reality of the context in which the project would take hold. As part of the design process, it is essential to involve the people who ideally will have to take advantage of the conceived solution. This is because it is important to understand the point of view of all the actors involved, who know the context, its features, and any barriers it presents more than anyone else. The interviews in this phase were not used simply to verify what was learned from the theoretical framework, but above all to start a discussion that would produce new insights and inspire the project itself. In the case of this project, we contacted three primary school teachers (hereinafter referred to as A., T., and P., for privacy reasons) who work with children between 10 and 12 years old, identified as the most suitable audience because they are old enough to know how to work with data, but not yet at a stage where they potentially would have found this experience easy and boring.

In preparation for the interview, a structure was prepared based on previous knowledge and the missing notions to develop a solution (Appendix 10.A). The layout of the interview is divided into two fundamental parts and it is meant to be conducted in about an hour. The first consists of a series of questions closely related to what concerns the direct experience of the teachers and which therefore could not emerge from the literature. The questions are divided into three macro-areas of investigation: general information on the life of children in the classroom, the type of activity and the curriculum that the school offers, and finally the materials that are used in education. Although the structure presents a specific list of questions, the goal is not to obtain statistically significant data but rather to exploit the points as a starting point for a discussion. The second part, on the other hand, is structured around the two concepts presented in the previous chapter. They serve as a pretext to concretize what was discussed in the first part and to verify the concepts developed from the literature. Interviewees are asked to observe and reason with the visualization in Figure 5.2, analyzing the individual dimensions and how they can best be developed according to their point of view. Before the actual interviews, a pilot interview with a person external to the project was carried out to verify if the structure could work and what could be some difficulties not foreseen up to that moment. The structure proved to be functional and the duration of one hour was confirmed, without further modifications being necessary.

6.2 MEETING WITH THE TEACHERS

The interviews were conducted during the same afternoon, one after the other, in the same settings and in the same context. Each interview was recorded, in agreement with the interviewees, for subsequent transcrip-

tion and analysis (Appendices 2 and 3). In both interviews, the structure presented worked well and led to the desired results. The only negative aspect was presenting the two examples of concepts: it was necessary to insist that they did not need to fix the presented solutions but rather think about the individual elements. Nevertheless, with a more determined explanation, it was possible to talk about the single dimensions in such a way as to obtain an insightful discussion.

The first interview was conducted with A., a former elementary school teacher who now works in a museum and exhibition context in which children are also involved with tailored experiences for schools. The full transcript of the interview is provided in Appendix 10.B.

The following are the main points that emerged during the interview.

- Movement and physical activities are important to keep the focus on lectures and there is a good chance that those kinds of activities would be appreciated, both by teachers and children. The general impression in the schools nowadays is that the movements emphasize focus.
- In the Swedish school system, there is an option, called "elevens vall", whereby children can choose a subject they want to focus on more. However, A. states that it is hard to manage due to time and resources, but is interesting for kids. Schools sometimes have dedicated weeks or days for certain topics and, if possible, they give the chance to children to choose a topic, both individually and as a class.
- Data as a topic is almost not mentioned at all, children's data knowledge is more based on programming and social media behavior.
- Probably 10 to 12 years old is the best age to let them reframe what data is or to introduce data in a more empowering way because they are at the end of the middle school and, in A.'s opinion, "they are more aware of the concept".
- A. thinks that Lego bricks are a good solution because they give the possibility to do both simple and more complicated things as "everyone knows Lego bricks".
- Subjects in school are really distinct, but they might take advantage of physical material to initiate a collaboration between teachers. One barrier to making this happen is that it requires time and effort on both sides: probably it is easier in a small school where the smaller number of professors and students allows for better collaboration.
- It is important that if the activity is carried out at home, it should be free of charge for the children and their families as part of the school curriculum.
- Online shared spaces, such as Google workplace or classroom or collaborative shared online board, could provide a way to follow children and involve parents in the activity.
- A game could consist of a mission with tasks. Instead of individual rewards (stars, points...), children could help each other as a group to earn something useful for everyone in the game.
- When he worked as a teacher, A. used to make up adventure stories for children to convey teaching in a more engaging way.

The second interview was conducted simultaneously with T. and P., thus exceeding the scheduled time but with a greater possibility of discussion and exchange of ideas. Having two people discuss together not only leads to a greater amount of information but gives the opportunity to hear two similar points of view but with different experiences discussing each other without the influence of the interviewer. Both teachers work in the same school but teach two different subjects, thus having to deal with different contents in the same environment. The full transcript of the interview is provided in Appendix 10.C.

The following are the main points that emerged during the interview.

- Teachers rarely have a standing lecture. They usually start by introducing the lesson's goal and go through it, maybe with images on the board to help. Not every class or teacher does it this way, it varies a lot, but some sort of engagement is needed to keep children's interest. Similarly, at the end of the lecture teachers try to understand if students reached the goal.
- They try to combine subjects but it requires a lot of time and effort and it also depends on the kind of activities and subjects. T. and P. both agree that it would be ideal to work under a theme, where every kind of subject can come together and combine ideas.
- Children sit in pairs in class and usually work in pairs. However, the environment might be rearranged if needed depending on the activity.
- Teachers do not have a lot of concrete material to work with. They both agreed that something physical would help to learn and that a lot of kids need that kind of learning. T. stated that some of the children "can't learn without that" and that they can show their creativity and how they learn through creativity instead of being in a normal classroom environment.
- When it comes to data, probably children's only knowledge is that "data" is something related to computers or an information-gathering activity, only related to scientific research. In math, they use tables and diagrams to work with data, but it is only about that and still a smaller part of the curriculum.
- One thing teachers wish children know about data is that behind what they are doing with their smartphones there is something happening, someone is tracking data about them. The concept is not part of the curriculum yet, they only get some information about having good behavior on the internet.
- P. mentioned that also she had problems finding the right topic to collect data on because she was not trained for it. Therefore, finding a good topic, something countable might be a challenge for teachers as well.
- Children need some guidance when it comes to choosing a topic, but a nice solution would be to let them have a choice. T. suggested giving them options related to their interests.
- Children usually do not have so a lot of homework and do not get help from parents, therefore an activity to be carried out at home might turn into a failure because some students would not achieve any result. P. thinks that "40% will never do anything. 40% has never even returned homework."
- In their cases, classes work well in groups and they try to combine them so that they help each other. Groups are not randomly formed but they try to match children based on their needs.

6.3 INTERVIEWS' INSIGHTS

In order to recall the insights from the previous paragraph, the next step was to resume the recordings, transcribe them and analyze them again, to mark down insights and ideas that may have been missed during the interviews themselves. In a similar way to what has been done for literature, the technique of mind mapping has been adopted, in this case through sticky notes and a whiteboard (Figure 6.1). After a first round in which all the findings were noted without an apparent logic and a structure, all the sticky notes were organized on the whiteboard, grouped by themes and ideas. As a further level of detail, they were divided between objective facts and personal thoughts of the interviewees, as well as distinguishing the interviewees themselves. This last division made it possible to compare the different experiences and therefore to identify elements in common or not. It is interesting to notice that the structure of the notes on the board does not reflect the division of the interview questions: this is probably due to the fact that, as already mentioned, the questions were simply a guide, and what emerged is a discussion without a defined structure that led to interesting unexpected results.

Surprisingly, the more objective notions such as the duration of the lessons, the number of students, or the subjects did not prove to be fundamental for the development of the project and did not feed the discussion. This is because, although in practice it may affect the functioning of the activity, they do not modify the fundamental concepts on which the research is based and intends to investigate.

All teachers confirmed that an active and physical experience works better than a face-to-face lesson in terms of learning, despite disagreeing with what they called "brain breaks". On the one hand, they can be entertainment that relieves stress during school, on the other hand, they can be a pretext to further distract from studying and might affect learning. In any case, the answers confirmed how the use of physical materials, potentially in the form of a game, can be fundamental to convey otherwise more abstract concepts and to offer more interesting and engaging teaching. As for the downsides, everyone expressed doubts about the feasibility of activities that go far beyond the curriculum or that involve collaboration between different teachers. In both cases, time and resources are big management issues that are difficult to overcome, as already highlighted by the Ching and Wang (2012) research. Moreover, at the moment the use of materials other than



Figure 6.1: The sticky notes with the insights from the interviews, before and after organizing them.

canonical ones is very limited. The only examples given are art materials, used solely for teaching arts and crafts, and some tools to count or visualize geometries in mathematics. At the same time, the teachers think that children would hardly have the ability and the desire to build materials from scratch, but it would be better to use something already defined and ready that still guarantees a certain flexibility.

The teachers presented a similar scenario in terms of the kind of activities to be carried out. Children need guidance because they have different interests and personalities for which they may or may not succeed in coping with the activity. An issue in this direction that clearly emerged is the choice of the topic on which to collect information: being new to the field of data, it could be complicated and possibly stressful to have to think about something that meets the requirements of the activity. The only difference that emerged in this sense is the help they could receive at home: for A. the parents could be helpful, while for T. and P. it would be unlikely that this activity would be successful outside the school. This is due to the fact that social factors come into play and make the experience of a class or school very different from that of another. In general, the first answer to many questions was a generic "it depends", since the context in which a project of this kind is settled significantly affects its success. The same variable plays a fundamental role when it comes to working in groups or individually, as it depends on the relational dynamics within the class and the personalities of the children. In general, the teachers think that it is possible and useful to make children work in groups, provided that the groups have been formed in such a way as to balance the preferences and abilities of each child.

Finally, as regards data literacy, the initial feeling is confirmed that it is a topic that is still almost totally absent in the curriculum. As already explained by Stornaiuolo (2020), most of the youths identify data as "information or numbers, facts, and graphs". At the same time, the teachers would like the children to understand better the role that information has in today's communication. P. gave a clear example of children that obtained a completely wrong perception of an event due to the coverage given by the algorithms of some social networks. As of today, the one thing that comes closest to this field is some exercises during the hours of mathematics which in any case are still a small part of education and relegates the role of data to statistics alone.

7. Final concept generation

This chapter contains the last phase of the project, in which the notions of literature and interviews are brought together in a single concept that led to the creation of the final artifact.

7.1 IDEA REFINING

The aim of this project is to produce as a final outcome a tool that would answer research questions. In order to produce the final artifact, the last step consists in combining the theoretical knowledge of the relevant literature and the ideas obtained from the interviews. Below are highlighted the essential features that this solution presents to satisfy the prerequisites, following the same structure presented in Chapter 5.

Components and information documents

The materials should be something affordable, for which children do not encounter particular barriers. They would unlikely build the tool from scratch but at the same time, they need something that provides a good degree of creativity and freedom. It would also be good to have rules and a guide that provide participants with a path to follow, thus avoiding feeling lost by not knowing how to act.

Environment

Being part of the curriculum, the ideal is that it should be included as much as possible within the lessons, without drastically altering them and taking advantage of the classroom environment. For this, a solution such as "homework" is to be excluded.

Purpose

The interviews underlined how purely theoretical teaching is challenging for children, so it would be better to include a creative and entertaining component that actively stimulates children and results engaging for them. However, the general objective remains education.

Content and narrative

Both personal and educational topics can work as long as they are established a priori by educators. The important thing is that it meets the teaching requirements and that the narration follows a logical and rational path.

Prerequisites and complexity

Both the literature and the interviews have confirmed that there is a lack of knowledge in this field. For this reason, the project must be as affordable as possible, leaving any barriers only to the subject of data collection,

as it is part of the learning process. The choice of the topic should reflect the children's abilities, as well as the materials, should be easily manageable.

Participants

As mentioned from the beginning, children need a figure that supports them throughout the process, but according to the interviews, it could be difficult to involve parents. The most suitable person is therefore the educator, one or more, who prepares the activity and leads it for the entire duration.

7.2 ARTIFACT OUTCOME

Based on the points just presented, the final outcome is the “Data bricks space mission” toolkit (Figure 7.1), a simplified version of a role-playing game, where the teacher acts as a facilitator and Lego bricks function at the same time as props for the storytelling and as a material metaphor for data. The target, as confirmed by the interviews, is teachers and educators in general who work with children aged 10 to 12. The kit is intended as an aid in teaching the collection and interpretation of data, intended as qualitative or quantitative information that represents a specific phenomenon. Through specific tasks, the teachers guide the children into collecting data about a topic chosen within the curriculum. It takes place at school so that children are followed by teachers. It is supposed to be conducted in groups, two or more, and each group eventually presents its findings to the rest of the class.

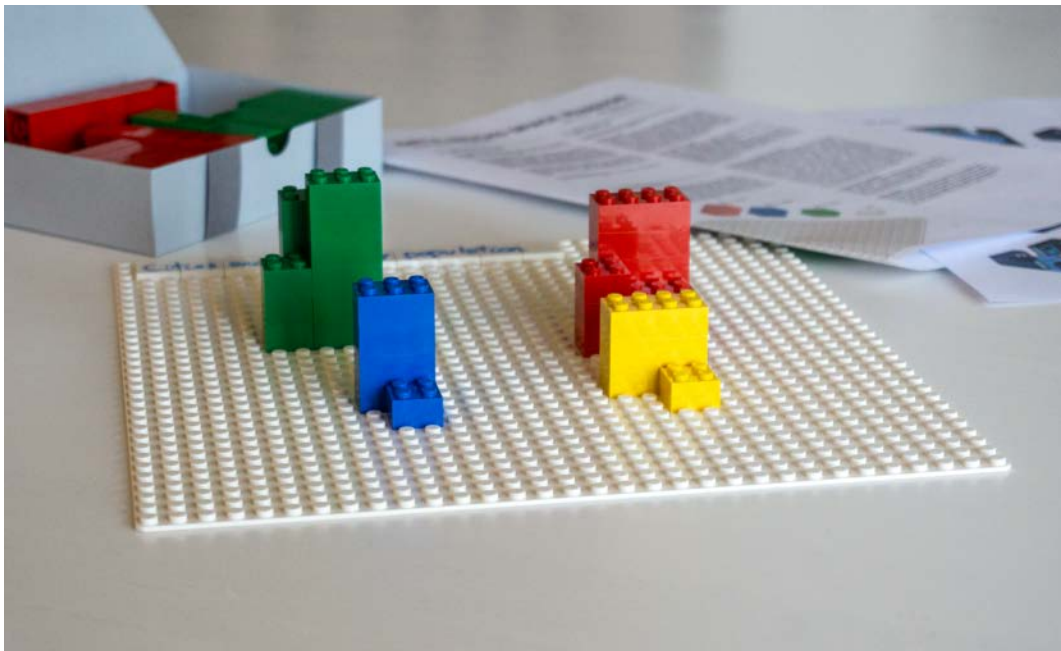


Figure 7.1: The “Data bricks space mission” components.

A mission in space

Through the toolkit, children are invited on an “adventure”, a special mission on a futuristic spaceship to save humanity from aliens, guided by their Captain, the teacher. Each element of the kit helps build up the fictional narration in which children are asked to face different task on the spaceship, which in the reality consists of a data collection to answer a question. Students are supposed to look for information through the resources the teacher provided and collect relevant data to discover something about the chosen topic. It’s suitable for both every specific subject as well as an organized interdisciplinary activity, in the case teachers want to work together on a common topic. For example, kids might have a “mission” for each subject. Much is left to the teacher’s creativity in introducing the topic in an interesting way. The toolkit only provides the physical materials to facilitate such an activity.

The teacher’s guide

The teachers are provided with a guide (Appendix 10.D) explaining what the kit consists of and the ideal path to follow to carry out the activity. It is a list of bullet points that the teacher needs to follow through the preparation and the conduction of the activity. Moreover, in preparation for the activity, the facilitator, the teacher, or the educator, is asked to prepare the classroom environment, which in fiction corresponds to the spaceship. Each desk corresponds to a room of the spaceship, in which a different task is presented. To help with this task, a ready-made example of a class/spaceship floor plan is provided with examples of four tasks suited to the experience (Figure 7.2). The teacher is required to design another floor plant that corresponds

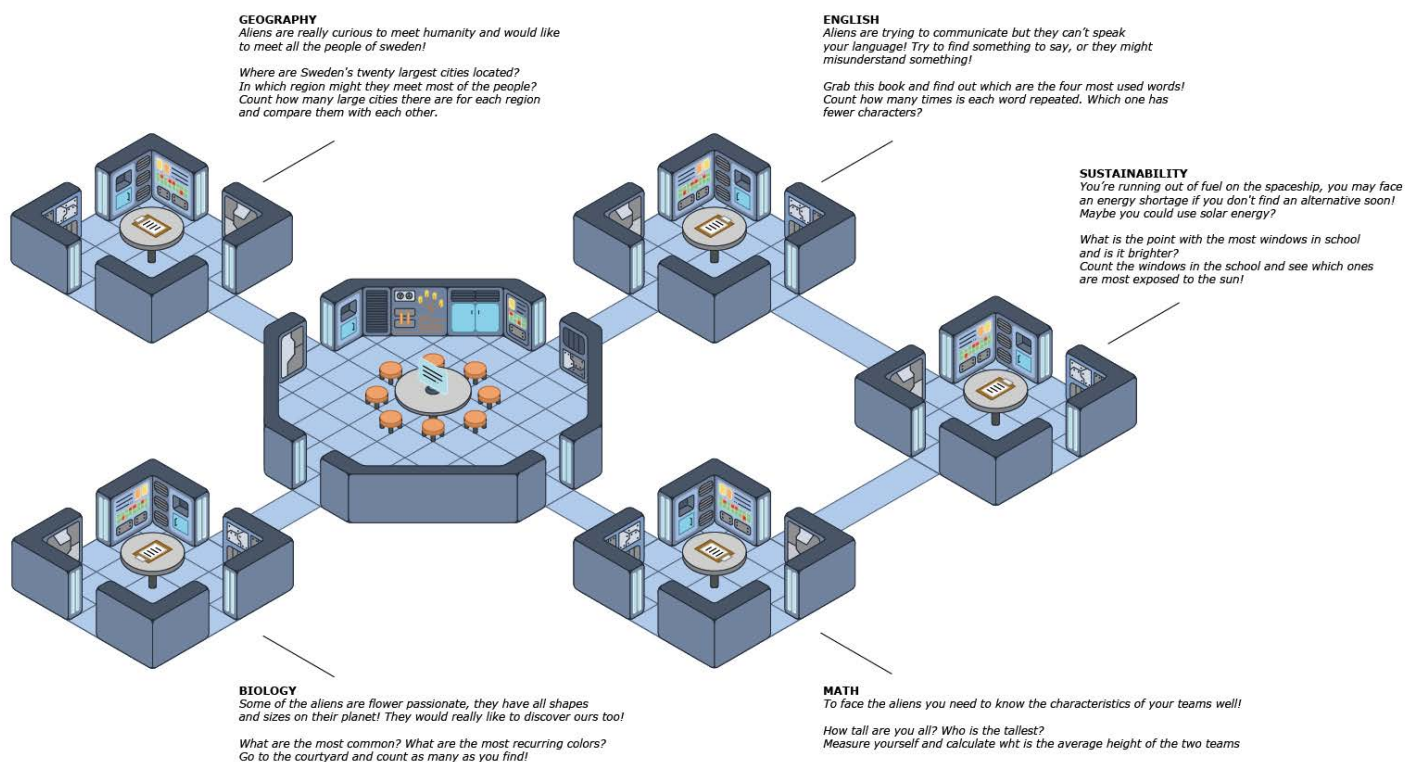


Figure 7.2: The example of the spaceship floor plan provided in the guide.

to the tasks they wish to carry out, using the paper shapes of the rooms provided in the guide. These cutouts are assembled to create the floor plan for the activity that will be carried out. Finally, it explains how to support children in considering bricks as tokens representing data, proposing a grammar that defines the metaphors between data and their representation.

The bricks

Together with the guide, the materials consist of a small paper "suitcase" that the children take with them on their mission and which contains a set of Lego bricks composed as follows:

5x	2x2 brick, in 4 colors
5x	2x3 brick, in 4 colors
5x	2x4 brick, in 4 colors
1x	32x32 white base
10x	2x2 flat white tile

Lego bricks provide a simple and yet customizable solution. This combination offers three possible dimensions to work with, one qualitative and two quantitative: four different colors to express different qualities, three different bricks' dimensions, and the number of bricks chosen. The base works as a sort of clipboard, on which children can "annotate" the data and therefore build the physicalization. This provides an environment that carries three other parameters as in a three-dimensional Euclidean space, with width, length, and height. The white smooth surface of the flat tiles provides a space used to annotate a title for the task at the top of the clipboard: using a whiteboard marker the kit can be reused several times for different topics.

General aspects

The activity is deliberately open and without too strict rules, it is not a well-defined game. This is because the effectiveness of a solution with multiple boundaries and rules is not certain in such a varied and indefinite public: children have different approaches to learning, more or less knowledge of game dynamics and the topic of data itself is already a novelty for them (and therefore an obstacle to overcome). On the contrary, this freedom of action, at the discretion of the teachers, allows a greater adaptation to different contexts and objectives.

There is no formal definition of what data means, but rather the teacher should guide the children to experience on their own what the data are and eventually help them understand what they have been working with. It is supposed to be fun and entertaining for children, who discover something new almost without noticing they are doing something educational from the curriculum. The aim is to make them understand that the data can be about different things and are not strictly related to a school subject. More generally, the educational goal is to make children understand that what they learn in school is not learning for its own sake but is about the real world outside of the school.

7.3 IDEAL EXECUTION

What follows is ideally the execution of the activity. It is explained as theoretically conceived so far but has never been employed in a real situation.

With an estimated time of 40 minutes, the teacher begins the preparation for the activity. The topics should have already been decided as part of the curriculum and now need to be translated into a task for the activity, as reported in the examples in the teacher's guide (Appendix 10.D). The task should be a straightforward question that children will be able to answer by gathering data. Moreover, it should be related to the sense of the story the teacher wants to tell so that it can work within the context of the general topic. The teacher must at the same time provide the source from which students can find information which could be, for example, books, the internet, the school library, lecture notes, or other sources to which they have access.

Once this is done, it is necessary to prepare the physical environment in which the activity is carried out. Based on the number of tasks, the teacher prepares the spaceship's floor plan with the cutouts provided, making each room correspond to a task. This plan is then translated into the arrangement of the desks in the classroom. Each desk stands for a room in the fictional world, with a larger desk, perhaps the teacher's one, in the center to represent the Command Room. Before starting the activity, a "Data bricks space mission" toolkit and the resources from which to take data must be present on each desk.

The last stage of preparation consists in dividing the class into groups. The division should be done according to the abilities and preferences of the children, in order to have balanced and equal groups.

This whole initial phase can be carried out by involving the children or not, depending on how much the teacher can find it an interesting and formative activity for them.

When everything is in place, the teacher presents the activity to the children. The idea is to develop a tale that students want to feel part of. The teacher plays the captain of the spaceship, encouraging the children to join them as brave little troopers. The educator will then go over the components of the toolkit and how they can be stacked and combined. Definitions and theoretical notions that can dull or confuse them should not be mentioned in the explanation. Then, the teacher helps the children to define the goal of the single task on the clipboard and to define the grammar of the bricks, finding a link between the types of data they can discover and the different shapes and colors. When the actual data collection begins, the role of the teacher is of the facilitator, asking questions and making observations where students are struggling or not noticing something. Once all the groups get to a final construction of data with the bricks, the teacher gathers them in the Command Room and lets them present their findings to the rest of the class. The educator should foster the discussion with questions and observations that make students reflect on the data they represented on the clipboard. If the visualizations realized are correct and really represent the data, the mission is accomplished and the aliens establish a flourishing collaboration with the Earth. If this were not the case, the aliens could not understand humanity and would cut off communications. At this point the teacher can choose to have the children retrace their steps, explaining how the data should have been collected correctly and thus letting the children succeed in the mission.

8. Conclusion and discussion

This chapter closes the study by analyzing how the presented project has a solid foundation in previous literature and how it can potentially be developed in the future.

8.1 LITERATURE VALIDATION

The proposed solution aims to follow and respect the theoretical premises that should guarantee its validity. The most recurrent reference is to the concepts of data physicalization. Through the use of Lego bricks, which have a clear physical presence, and other physical objects, the project incorporates all the benefits of data physicalization presented in (Dragicevic et al., 2021; Huron et al., 2016; Huron et al., 2017; Jansen et al., 2015; Karyda et al., 2020; Thudt et al., 2018; Verhaert et al., 2021). The toolkit is based on the basic components presented by (Huron et al., 2014): Lego bricks constitute the tokens, the environment is represented by the Lego base, and the activity expects the teacher to build a suitable token grammar for children as well as the assembly model. In a similar way, the variety of pieces gives the possibility to encode *marks* and *attributes* (Kirk, 2016; Munzner, 2014) in different combinations. Encoding and physicalization combined ensure a strong connection between data and the real world (Thudt et al., 2018). Furthermore, being the activity very planned and having the materials ready for use, the barrier of knowledge and tools is considerably lowered and consequently, an act of democratization is promoted, allowing children to be able to work with data (Esterhuizen, 2012; Huron et al., 2014; Huron et al., 2017). To avoid difficulties for children in choosing a topic to work with, as presented by Hutchison et al. (2000), the project asks the teachers to work on it and provides them with examples in the case they feel lost about finding a suitable theme. Finally, the project follows what has been explained by Stornaiuolo (2020) about changing the role of children from consumers into data agents.

8.2 FUTURE DEVELOPMENT

As mentioned in Chapter 3, the ideal Design process requires a series of loops in which the process is iterated to lead to an increasingly detailed solution. In the case of this project, the next natural step would be to test the final artifact with the teachers who participated in the interview and eventually expand the field to other educators, to obtain feedback and verify the validity of the proposed solution. In this process, the interviews were the focal point of contact with the context in which the project would be positioned and it involved "only" three instructors. Widening the network of people involved would potentially increase the possibility of improvements and further ideas. As emerged from the interviews, in the field of data literacy for children a lot "depends" on external factors that require flexibility and adaptation. Therefore other ideas certainly would lead to a richer and more adaptable solution to other contexts. It would also be interesting to change the environment, such as a youth center or a library, to understand how the context can change the characte-

ristics of the Data Bricks Space Mission. Just as testing this project in different countries with a different school system would test how much it is based on the characteristics of society and how much it can adapt to other social norms and habits.

As for the artifact itself, a dedicated study would be needed for the guide itself as a fundamental element of the "game". For this project, no game design dynamics have been studied that would open the door to another whole field and would certainly bring improvements to the current experience.

Further research would also be needed for the materials that make up the toolbox. The number and type of bricks are based on personal sensation according to what was thought to be reasonable. The kit can be expanded and adapted with different pieces depending on the needs. More generally, the choice of Lego bricks is design-driven, drawn from ideas inspired by literature. However, it cannot be excluded that they can be substituted or enriched with other materials. At the same time, a testing phase would help to understand their strengths and weaknesses and to clarify how they are functional to education. For example, research already exists on the use of Lego bricks in teaching mathematics and statistics.

Finally, in the design process, the personal visualization component for self-expression and empowerment gradually decreased as the focus shifted more to the school environment. Looking at the literature, it cannot be ruled out that such a toolkit could be adapted for the collection of personal data by dealing with the issues presented in Chapter 2.

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10. Appendix A - Interviews' structure

INTRO (10 minutes)

- Introduce my self
- Explain the project
- How can teachers help us
- Sign the consent form and ask for permission to record the interview

QUESTIONS (Time and spaces / Activities / Materials) (10.00 - 40.00, 10 minutes each)

- **What is the children's schedule and in which setting do they spend time in relation to it?**

A typical day at school of a fourth-grade student, like how many subjects and teachers do they have, how is the time divided ...

- How's the week at school organized for students? Do they have a specific timetable for different subjects?
- What times do they have? Breaks? How long are the single time slots or lectures?
- How much interdisciplinarity is there? Or are the subjects clearly divided?
- How many children are in a class?
- How much time do they spend on their own vs with the teachers' help?
- What's the classroom setting? Individual or collective desks? Other "working stations" that are not regular desks?
- Is there any other space they use? Outside?
- How much time do they spend in class and outside? How do activities change based on the space around them?
- Do they participate in the management of the classroom environment? Are there any materials, prepared by them, "exhibited"? (Like hanging on the wall)

- **What kind of activities do the children have? How is the curriculum currently structured?**

Kind of activities they already have, if they have more sitting lectures or more participatory activities, if they are more educational or there's some sort of entertainment component and also how do you pick the activities, if you get a feedback from the students

- What's the level of children's involvement in learning?
- What are the means of learning?
- Do children usually prefer guided activities or more free/expressive ones?
- How much help do they need and get?

- What makes activities successful?
 - Can children choose activities? Or give their feedback about them?
 - Would children be able to find a proper topic on their own? Or do they need guidance?
 - What kind of topic do you think might interest them?
 - Is there already any such activity in the curriculum? Something this project can fit in?
- **When it comes to data, what's their knowledge about it? How is that done within the curriculum at the moment?**
 - What level of knowledge do they have in data, math, statistics, diagrams ...?
 - Is there something you wish they knew? What's challenging?
 - What do teachers know about data?
- **What materials do children use every day? Which ones are they familiar with?**
 - Beyond pen and paper, do they use different materials in the classroom? Which?
 - Do they have “manual, constructive” activities?
 - Would they prefer to build their own or to use pre-made objects?
 - What's the correct approach to let them think of what they care about?

CONCEPTS (15 minutes)

- Introduce the two concepts
- Discussion
- two concepts side by side to compare them
- point out the different dimensions/features involved

CONCLUSION (5 minutes)

- Thoughts? Questions?
- What do they think of the two concepts
- Any other feedback

10. Appendix B - A. interview transcript

Lorenzo 0:00

So we're just now throwing at you a bunch of questions. If something's not clear, just ask, it's not a big problem. We have three different parts. And it's to, as I said, to better understand how was the typical day or life in general, or the children at home, school, sorry, things like that. And in the specific, we're trying to think about that fourth grade students. So first big question is what is the children's schedule? And in which set the do they spend time in relation to the schedule? I'd like to learn more about, like a typical day at school. Like how many subjects do they have, how many teachers they have? How the time is divided? Those sort of stuff.

A. 1:16

You want to know everything. Okay, so typical schedule, runs from around eight until 2.30. It has changed some during the last 10 years, due to the new regulations and curriculum, the adding stuff, adding time to subjects like more math time, the Swedish time. So the need to prolong the days. The children are not so happy. Most of them, of course, yeah. So around eight to 2.30. And they have like, it's very different from school to school, how many subjects a day. Some schools have like, themed weeks, a lot of math time, two weeks in a lesson. In my experience is like, three to four subjects a day. So always Swedish and math, a lot of time in the curriculum, almost every day. The subjects that usually gets cut or so it's like technology or programming, that is quite new. And a lot of teachers don't know how to program how to teach programming. So it gets like sidelined. Then they come here, we have like we have saved up four hours from last term. When it comes you use all four hours in one day. Of course, it's not supposed to be like that, but okay. So that's my general feeling that some subjects like crunch together to do a theme day. And then there is social, It's called S. O. in low grades. You're looking at 10 year olds, fourth grade. Yeah, they have geology and all subjects separated. Teach them as a group.

Miriah 2:13

Like my son, they were just doing a religion, like a couple of weeks on different religions. During the S.O.

A. 3:42

yeah. S.O. But in the fourth grade, they're like to separate it. So it's religion and geography and history...

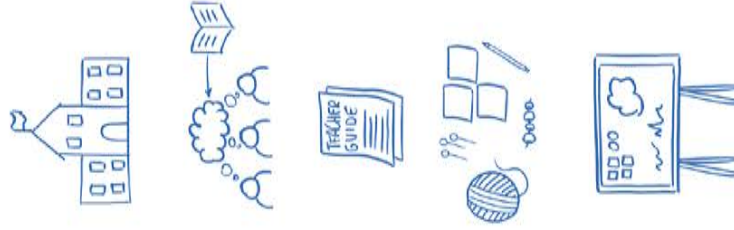
Lorenzo 3:54

How's the time divided during the day? Like how long is the lesson?

A. 4:01

Usually an hour, an hour, 15 minutes, perhaps. More and more schools tend to shorten the lessons and put in more like activities, more short breaks. Just as a way to try to get students focused. Swedish schools, Swe-

CONCEPT #1	DIMENSION	CONCEPT #2
At home	PLACE	At school
Personal, children pick their own	TOPIC	Related to something already addressed in some subject
Individual	INVOLVED PERSONS	In group, perhaps the whole class
One guide for the facilitator, one guide for the child	GUIDANCE	One guide for the facilitator
Didactic	PURPOSE	Entertaining
Same for everyone	MATERIALS	Topic tailored, chosen by the group
Exhibition	OUTPUT	Classroom shared board
More creative	FREEDOM	More boundaries



dish school system has been struggling a bit. Notice the PISA rankings. So it's like a global ranking system of school systems. Swedish school system has dropped several points for years. And it's been so for like 15/20 years. So it's no big news. But still, the last measurement was like "this is wrong, we must do something". So change the curriculum, put in more time and they emphasize you need something. Need to get the students more focused, you need to bring in more activities, bring in more like physical activities, get them up and moving. prolong your days fine, but include more physical, running, jumping. More like athletes.

Lorenzo 5:22

Is it like during only the breaks? Or do they have a dedicated time during the whole day to do so?

A. 5:28

Yeah, some some, some of them would like to dedicate the time. And others, like, just sneak them in small time on schedule, because you need to feel like 80 minutes this day in math, but we do 60 minutes math time and 20 minutes is movement. Moving around, get our pulse up.

Miriah 5:48

Get the wiggles out. Yeah.

A. 5:49

So it's like I can if I'm like I can I can think that in 10 or 15 years, perhaps there's like movement as a subject. Is supposed to have almost 60 minutes work and 20 minutes movements. And then your break time. Go out and play, also.

Miriah 6:10

It's kind of interesting to consider for activities. Yeah.

A. 6:14

So any activity that involves movements will be appreciated. Yeah. And used in schools.

Miriah 6:20

Yeah. Yeah. Okay, that's interesting.

Lorenzo 6:29

Are those activities related to the subjects or not? Is it just to take a break?

A. 6:31

Not necessarily. If it's possible, yeah. But not necessarily. Okay. A lot. A lot of those are like, can be challenge of the day. Try to try to find these things or try try to do 50 Push ups on run around a friend or some even

follows like a YouTube channels. Now. The teachers do like, interactive games, some of them follow a YouTube channel, we'd run around in the jungle. Yeah. And I'm jumping and you're jumping? Yeah. Catch a star. Yeah.

Miriah 7:08

I have a second grader and he did only remote school last year. Okay. I witnessed a lot of these. It's like they're in a video game, or like jump left, jump up. He's like, catch a ghost. Yeah. It's crazy. It's crazy. Yeah, cosmic yoga was another really popular one that we had. Anyway, but they do love that. It's shocking how much he loves.

A. 7:30

It's like, it's like, kind of poor quality for graphic quality when poor script works.

Miriah 7:38

Boy, did he move his little legs

A. 7:40

My kids doing running at home, like, can we turn it on? Yeah. Okay, this is Tom, the teacher during the ghost dodging dance. That's like, more more common reason we say.

Miriah 7:56

So why is there this emphasis on movement? Is it because they think that kids aren't focused enough to learn? Or is that this there's something about movement? That is? I don't know. Very Swedish?

A. 8:09

No, I think the general impression is that the movements emphasize focus. The brain needs to be activated, and it's easier to like, keep focus for another 15 minutes. And Sweden is looking a lot to our neighbors in Finland. They're doing always very good in the PISA score, it was on top. They had like a combination of supporting says strict discipline. Students are highly motivated. The parents are highly motivated to have a like a state controlled school system. In Sweden, it's controlled by our counties or kommunen. So this this Swedish school system used to be controlled by the state and state governed, and then they say just "okay, you counties can do whatever you want, with the finances, with your funds, organizing place. And that's, that's the main key, they now look less. That's the main key points. That's when the failure began. So I have a lot of things to do and

Miriah 9:17

be more finished.

So looking at the time, maybe the next

A. 9:27

sorry

Miriah 9:28

no, that's for us not for you.

Lorenzo 9:31

Yeah. Don't worry about don't look at my papers. The second part is more about activities, like you were talking about. We're wondering what kind of activities children have. How is the curriculum structure right now you're talking about it a little bit. What we want to understand if like they have, again, here we're talking about this more sitting lecture or more participatory activities besides having fun outside. If there's some sort of entertaining component during the activity, the lectures and yeah, those kinds of stuff

A. 10:17

Just give me one question.

Lorenzo 10:21

What kind of activities do they have during lectures and beside them?

Miriah 10:25

Yeah. Okay, no, my son, he has these like activity days on Wednesday. That's the activity days and they go through and they do specific things. It's like what does an activity like in a classroom?

A. 10:37

It's more like a theme day. Or it can have activity days. We used to call them a theme day. Yeah, it's like today, or theme week. So this is the week we're working, we're doing we're doing space. And they try to like, twist all the classes and all their subjects to be about space and somehow or space related.

Miriah 11:04

So what would they have? Like what would be like? What are some of the, like, the activities that like working activities that you had in your classrooms? Like is it like, worksheets or cutting stuff out?

A. 11:16

Yeah, yeah, cutting stuff out, making modules. It might also can be like, worksheets, it can be group chat group works, group activities, it can be read this book, and talk about the book later. Watch this movie. More and more, with more and more media in the classroom. Now, a lot of classrooms have smart boards. It's like

an interactive board. So more and more teachers feel comfortable using it for showing children. Because when we have noticed that she really likes to watch the screen. Yeah, they focus on so if I'm supposed to talk about Earth, geology. They're not so attentive. If I make "Tom the teacher" talk about Earth. Yeah, somehow they pay attention and are interested. In some ways is more interesting. So more and more teachers use like technology and tools to help with communicate and learning. But in the classroom, there are like limited options, limited possibilities to make those things it's like we have kind of paper, we have scissors, and glue, we have paint. So paint, clip, glue. Yeah.

Miriah 12:44

All right. Are the classrooms pretty well stocked? Or like do teachers have to sort of supplement if they want to do something different?

A. 12:50

Yeah, if you do want to do something different? Yeah. Yeah, just knock it off. In order to you know, that's what I noticed. Something that I did was like, use, "hey, we are on Mars. And you guys on your side ...", I try to put on a play. So play that you're on the Mars. And here's the facts: you can't breathe. There's dust over there and you have to survive. Okay.

Miriah 13:23

And you just gave the kids time to like, perform that.

A. 13:25

15 minutes. Put on short play. Go crazy.

Miriah 13:31

Was it good?

A. 13:31

Yeah. Often. So it's like one way to like, work with nothing. Okay. So create something else than I am just talking about Mars. Yeah. We're gonna move about Mars. Yeah. That's one way.

Lorenzo 13:48

So you tried to have some more entertaining and interactive kind of activities to let them learn, not only from the lecture.

A. 13:54

No, that's my way. And I think there's a more more, I consider myself a young teacher, being 37. But my generation, it's what we really enjoy, we like to adapt a way. And it works really well.

Lorenzo 14:07

And can they, like, choose activities or give a feedback about it? Or choose a topic? Do they have a voice to choose something?

A. 14:26

We have something called "elevens vall", the student's choice. It's coming and going in the curriculum. Used to be like a subject in its own, like the students choice, then you go "I want to learn more about math". And I get one hour extra each week in Math. Someone maybe wants to know more about Mars, so give me space lectures in the Mars. So I was like, it was a bit tricky, but it was like a way to get to students to raise the voice and say, dive into the interests. And then was gone, taken away because that's really hard to do from teachers said it's hard to it's hard to like, get one what they want. And so like the politician said this is too much hocus pocus and they removed it to get in more math and English. And now it's kind of like if we can have like a school, this is today where the schools choice, and the school will set the topic. Okay, you can if we will learn more about Swedish history once a week or Wednesday afternoon, for two weeks. So it can be that way.

Miriah 15:44

I see. But it's at the school level.

A. 15:47

More and more. Some schools, they will do their own thing. They interpret the curriculum like "ok you can choose something around math", it's a bit a gray zone.

Lorenzo 16:02

And is it something that they choose individually or as a whole class?

A. 16:07

Can be both. Usually teachers like, we encouraged them, "I know that you need to focus on Swedish. Perhaps you should choose Swedish not music". But they all want to do, "I want to learn how to make movies. I want to play football. Do more sports, right?" "You should do more English". That's also the one of the heartbeats. We want to like, want to focus on we want to, like, encourage them in one direction where they want to another thing.

Lorenzo 16:46

So they still have some sort of guidance. They don't just pick a topic and work on it.

A. 16:52

yeah, teachers tend to, like, motivate them to choose something. Teachers think.

Miriah 16:59

So how is it? How well would it work in an activity? Like if you had an activity that had like, do this thing, but do it around any topic you care about?

A. 17:07

It's really hard. Yeah, it's really hard. It's hard even to like measure if it's a good thing. If the students learn what they were supposed to do learn. did have fun. Yeah, fun. Okay, but what did you learn? I don't know. Something about music, I think. I don't know if it's back now, I think this was like a new curriculum in 2011, that's quite long time ago. And this new one for preschool it's like, more additions. So there's not a new curriculum, but much more additions, and updates. We're excited to see what other teachers say they are, like active now. So yeah, it was like for four years since I was in the school.

Lorenzo 18:06

And when it comes to data, what's their knowledge about it? Do they have something in the curriculum like math? Or is it only basic knowledge?

A. 18:16

Yeah, data is almost not mentioned at all, in the in the math curriculum, or in the math topics. So it's like, they mention statistics and numbers, and, but not data itself. So probably in programming, they mentioned data, probably for the first time for a lot, a lot of them, I think, I think that they are a bit aware if they are talking about like, how to behave on social media, and then like, what to put out and what not to put out and how you should be aware of your images, pictures and stuff. And that's probably when they mentioned data. That's your data, personal data. So now they know that they're supposed to sign a form if they if the school wants to use the photos, so they know that they have some rights, some kind of ownership about their own images, but that's about it.

Miriah 19:17

right, but not they don't necessarily have the agency. They don't have knowledge of how, they don't have like agency about creating data. They're just sort of like, other people are creating data from them. . Be careful of that, protect that.

A. 19:31

Grownups use your data in harmful ways if you're not careful and have the best approach.

Miriah 19:38

Do you think that age group would be a good target age for reframing what data is or introducing data in a different sort of more empowering way?

A. 19:53

I will probably choose 12 year olds. The last in the Mellanstadiet, we call it middle school like. So I think that's nowadays, almost every student has a phone, so they could be aware of what data what it is. But I think like, I would choose 12 year olds, because they think I believe they're more aware of the concept. If you describe it to them, I think they would like to get the idea what you mean. 10 year olds is still quite a young age. Probably got the first phone, probably just start to realize that the world does not revolve around them. Somehow. Why did you choose 10 years old?

Lorenzo 20:51

It's somehow I guess, because we were figuring out that, if it's too young, probably they don't have any knowledge to do such an activity. And if they're too old, like, after middle school, they might be get bored about, you know, collecting data might seem boring, at least to them. So it was the age in the middle.

Miriah 21:14

We want them still sweet and nice and interested, and not cynical.

A. 21:19

From that perspective? Yeah. Okay, then 10 year olds. Perhaps?

Miriah 21:29

Well, maybe once once we have some sort of artifact would be good to get your feedback on what you think a good age is.

A. 21:39

11 years old usually come to us. They're, like, all eager to know, eager to learn. I'm quite positive to experience. 13 year olds not so much. Don't do them. So it's like, you get the most eagerness from the like, lower kids like eight year olds? They're eager to learn. They'll do everything. As long as it's something like something extra something out of ordinary. Yeah.

Lorenzo 22:16

I asked you about children knowledge, but on the other hand, what do teachers know about data? Like, it's something only meant for math teachers? Or, also, do they have teacher for each subject? Or do in general teachers know something about data and would provide some help?

A. 22:34

I believe most schools in the middle school they have perhaps they have a like a math teacher. She's or he's always having all the classes. But the most, the Swedish school system tends to be tends to go in that direc-

tion. So the higher math teacher for the school, she has all the classes. But like, 20 years ago, I was like, wanting to have all the subjects 10 years ago when I was a teacher in sixth grade, I had all subjects. I don't know music, but okay. That's how it was.

Lorenzo 23:14

So you're moving now to a teacher for each subject?

A. 23:20

Yeah, so probably then the maths teacher would know more about data than the music teacher.

Lorenzo 23:25

All right. The next part is about the materials they use during the lectures. So what do they use? Any physical elements, objects for everyday? And which ones are they familiar with?

A. 23:25

Pen and paper, scissors and glue? Yeah, probably tablets. Chromebooks, a lot of schools in Norrköping have Chromebooks. So now, they're not familiar with the mouse. So don't give them a mouse.

Miriah 24:01

My son's always coming up to my laptop pushing them like don't touch it.

A. 24:05

Yeah, mine as well. We have like 15 year olds here. They have never seen a mouse. What's this? No. Just scrolling, scrolling, scrolling, stop! I don't know how, how? which way? So don't use a mouse. So they're familiar with tablets and Chromebooks. And I don't know. Yeah. Papers and glue. Paint and pencils. Yeah, yeah.

Lorenzo 24:35

They have like more manual and construction activities, so they used to Yeah.

Miriah 24:42

And if a teacher wanted to do something that involve like non standard equipment, like, like egg cartons, yarn and feathers like was, can they get do they get access to that or they don't have to pay for that themselves?

A. 24:56

No, the arts and crafts like teacher used to have a big stock. And fritidshem was called, free time. Free time after school. Yeah. That's like part of the standard equipment.

Miriah 25:15

Right like my son is so he's sewing some sort of stuffed animal. Right. Yeah, so I guess a lot of stuff.

A. 25:23

It's easy to get. So, yeah.

Lorenzo 25:26

And do like to build stuff from scratch? Or do they prefer to use some maybe pre made objects? Like she mentioned yarn or Lego bricks? For example, here.

A. 25:39

Yeah, I would chose Lego bricks if I could. Everyone's familiar with Lego bricks. it's been around them since they were like, two years old. So it's almost everyone. Because you can do advanced or you can do simple. And Swedish schools in a general class, there's like, nowadays, it's like, so much with a adaptations to each students. Each student has right to have adaptations to the way to learn how to approach them, how they should receive instructions. And so if we can have like different sets, this is like a setup for someone who is not that into taking instructions at all, like a model that exactly like this. Someone will do fine with instructions on paper. Someone will do fine when you tell them what to do. Someone we need to look like look at a movie, or instructional film. Yeah.

Miriah 26:35

So the more adaptable something is the better.

A. 26:37

Yeah, and I think they the feeling of having something in their hands. So like, Lego bricks or feathers or whatever.

Lorenzo 26:51

You said that usually, the arts and crafts teacher is in charge of this. Did like, like try to involve those kinds of objects into lectures in like math, or other lectures?

A. 27:05

Probably, if the math teacher initiates it, initiates, like, the collaboration. Otherwise, it's like, very separate. I have my own schedule and my own plan with her and she has her own plan.

Miriah 27:22

Collaboration takes time.

A. 27:23

Time and effort. And if it's like a big school, and it's like, she's she's having all the classes in arts and crafts. And I have all the classes in math, and we have no time. In a small school perhaps it's possible. I used to work a lot with my arts and crafts teachers, because we were like, it's not small school. So we were like "today's we're gonna we're gonna learn about some addition. Okay, can you bring in some materials we can use? Probably we can build differences and look at the differences. build models and stuff." Yeah.

Lorenzo 28:04

So, we are done with those questions. And now, we want to try to introduce you two concepts about the possible activity that might take this. I want to ask you to try not to stick with the concepts themselves, but rather with the dimensions that you can see here. I will try to explain those. But try to think of those in the middle. Okay, the dimensions, the concept. So the first concept on your left, it's an activity that we see taking place at children's home maybe like it were homework, we would have to guides to help the facilitator, the teacher, and also the children. Of course, the one for the teacher would be to let them start to help them during the process. And the children one would be for the time they're at home actually performing the activity. It will be an individual activity. So each children chooses specific topic a specific thing to work with, with the help of the teacher, of course, so that they have the some sort of freedom, but they are still guided somehow. The materials they would use will be the same for everyone so that they don't need to think to create something, but in this way we reduce the effort of creating something from scratch. And at the end, it might be possible to have a sort of an exhibition in the class where every child can tell what they collected. What's their story there were, what was the date amount. On the other hand, the second concept is quite the opposite. It's thought to be in school during lectures, it could be somehow related to something that is already going on in school, like some subjects, some topic they're already talking about. It will be performed in a group with the whole class led by a teacher as well as a guide. But the decision would be made as a group by the class, by the whole class. We would still have a guide, but only for the teacher to help them through the process. And it could be possibly, to make it more funny for them to to have a game like they're not only collecting, but like this one you're doing, you're playing and while you're playing, you collect data, they material in this case would be like, tailored for productivity, and children choose what kind of material is better for the project. And at the end of the activity, the result, the output would be like, shear bore where they have been working for like a month, and you have that they have the output there again, so it's in the class, it's maybe on the wall, so everyone can get around and talk about it. So you can see there's quite a lot of differences. Basically, they're listed there. What's your thoughts?

Miriah 31:36

Well, let me just say these were just two hypothetical concepts meant to put these various dimensions on opposite ends. And so we're just, that's what these are. These are not hard and fast things. Yeah.

A. 31:50

I think the look like, like working concept on both ends.

Lorenzo 31:57

Yeah. What do you think it might work? What do you think might be bad for the activity?

Miriah 32:03

Or like, specifically, like, using these dimensions is probably, like, one of these things are you like, oh, that definitely wouldn't work. Or this could be a really great idea for these sorts of reasons like how to along these dimensions, or perhaps other things, what speaks to you as something that would be an effective activity or ideas to design around.

A. 32:27

If you are to do it at home, then it has to be something that costs no money, that's free. Because everything in school has to be free free of charge. So we can't be counting ice creams or something like that must must be something like access to counting steps or whatever. And for the guide part, could use like an online guide to have access to an online guide. Most children in school nowadays have access to like a common workplace, like Google workplace or Google Classroom. So they're quite familiar, I think, when it comes up, so you can put out the activity there. And everyone can follow up and the teacher can follow up with you, you guys as well. That's one way to like, also involve the parents at home. So I can be like a support.

Miriah 33:27

Is that effective? like getting parental involvement.

A. 33:31

I don't know, perhaps the Google Classroom works like, we have homework, and they can log into the classroom, and then the parents can see what they're supposed to do and just have a look at the activity itself and get more knowledge on how to support their child. So that can be one way. And when I say one tool to use as well as like, classroom shared board can be digital shared board, as well. They can put up thoughts and inspiration to each other and stuff. Yeah,

Miriah 34:07

What do you think of like an activity being designed for something that could be imagined as homework versus in class?

A. 34:19

Something that involves movement?

Miriah 34:22

Yeah, yeah. It's movement then teachers might be excited to try to incorporate

A. 34:31

For sure. I mean, it could work from home at home as well. I think most parents will also like to encourage the kids to like

Miriah 34:39

if you can design it for work on a trampoline I would love it.

A. 34:46

But it's all depends on which school and where you are, if like, a school in the middle of city. And you can almost assure that everyone lives in their apartment. They don't have a backyard. But I'm I don't know.

Miriah 35:05

What about the kids working by themselves versus in teams?

A. 35:12

That's also one tricky part nowadays because almost in every class, like, five to seven kids that don't get to work in teams. They don't do well. So, yes, group works is like tricky. In some school everyone's doing it and it's okay, it works more. But what's more common group is like, groupworks are a bit tricky. It perhaps works with smaller groups or two or three, perhaps it's like, limits. Of course, in the classroom, there's like, teachers arounds to support so. It could be like, a class as a group, plus, we divided the class in two usually, there are usually two, one teacher and one assistant, usually, so dividing the class in two, or do with us a whole group perhaps would work.

Lorenzo 36:21

So, to be more active, do you think it would be better to have it more entertaining rather than educational?

Miriah 36:32

Why aren't they both?

A. 36:33

Yeah. Give me both. Yeah. For sure.

Lorenzo 36:36

Of course, the purpose is still collecting something and thinking about it. But maybe a game could be better for them to get their attention.

A. 36:46

I think I think like the part where you're supposed to collect something. That's that will do it. That's enough. That would do the trick. You have a mission, collect and do something out of the ordinary. Yeah.

Miriah 36:59

Mission. Impossible. Your mission? Should you choose to accept that is count how many things of milk are sold in the cafeteria?

A. 37:07

Yeah. You have, like, we're supposed to complete five missions during a week, your mission a day, or something like that. One mission away, then it would keep the spirit. Yeah. Stay motivated.

Miriah 37:25

How well does like sort of competition or sort of gamification of things? Like, see who can earn the most stars? Can you reach this limit?

A. 37:33

I would avoid that. Teachers tend to not use levels or stars. They don't want to like to say, create hierarchy. For the whole, right. So if if the class completes mission one to group then you get something. It also is now reached level two. You haven't earned yourself new gear your new crown or sword

Miriah 38:08

That is so Swedish. So different than in America.

A. 38:12

So not competitive. Yeah.

Miriah 38:15

Interesting. But the whole, like, what can we do as a class? How can you contribute? Let's reach this goal. Cool. I feel like there was another one on here I was really interested in. Oh, we kind of asked this earlier. But you know, one thing we've debated thanks a lot is how much agency to give the kids in terms of like, a topic around which they might be collecting data versus having the activity or the teacher be like "we're going to collect about like, water and how much water you drink". Like, do kids appreciate having that kind of agency and freedom or is it just hard? or is it really like, it depends?

A. 39:01

I guess if I was to choose I would like the teacher to say "we're supposed to like some water, estimate how much water we drink or I'm gonna guess how much we're having each lunch. So if you can be specific, and guide them that would be way more easy to comprehend for the most.

Miriah 39:27

Yeah. Any other questions? Runnin up on the end of time?

Lorenzo 39:34

Yeah, actually don't think so. Do you have any?

Miriah 39:41

I mean, I have so many questions. We're gonna respect your time. Also this is not my interview. A little bit by interview, but I'm not the one that's actually that needs this information to design something I just want to learn more about school system.

Lorenzo 39:57

Is there something not clear from this concept?

A. 40:01

I think it sounds like a good plan. This, if I was if I was was to get this as a teacher. I would be like "Okay, that seems like we have a good concept. It's doable."

Lorenzo 40:21

Can you see such an activity to take place in school?

A. 40:24

Yeah. Just come up with activities. That will be the challenge.

Miriah 40:31

Okay, can I ask one last question before you do, what you're gonna do? If you had a magic wand, and you could go back to when you were actually in a classroom? Can you describe? Like, if someone were to give you something to do an activity for your classroom? Can you describe what would make it magical for you? Like, what's the ideal thing that someone could give to help you teach kids in this case about data, but really about anything? What are the things that would make that an activity so great?

A. 41:03

Something about like "okay class, it looks as when there was like a mystery box of my desk this morning. Someone dropped it off with a note saying Hi, I'm sorry, I need help with something, please", then I opened it in this like...

Miriah 41:25

so like, being able to build up a whole sort of magical story and context

A. 41:32

Yeah like treasure hunt or something. I've been doing it like, several times, like you're used to this kind of adventures learning. Like, you found like a bottle in the river, or like, this mysterious notes came in. Some person trapped on an island, we need to find them.

Miriah 41:56

Did the kids believe you?

A. 41:59

They believe because I believe and they play along and they like the concept so they're playing along. Yeah. In the Center, we do escape room here in the Center, like this suppose like you find boxes and unlock them and do complete tasks and resolve the code. They know it's all made up, but still. They know that we locked away to one of the boxes downstairs and throw away the key. So they need to find get a key from us. It's like a six digit key. Yeah. So I've completed all the missions, all the tasks to get the key, if you don't, so when we say it, sometimes we walk away without the phones for a week. Okay, so they know we're kidding. But they're not sure, they're not sure. And they are like 15 years old. Right? Yeah. So my kids were like in school, but like, yeah, it's 8, 9, 10 or 11 o'clock. Yeah. So the concept around the adventure will work, especially especially for 10 year olds. Definitely.

Miriah 43:03

Right? Because they're still sweet. And they're not. Yeah, they're not jaded about it.

A. 43:06

So something about that. Yeah. Some mystery, or ...

Miriah 43:15

Yes, like "we need to work together. We need to have some very specific things."

A. 43:21

"We need to be agents or we needed to be like, find secrets, something or group or team or special". And perhaps you'd like to give us some token, like the left us with those instructions on these tokens. We're about to

receive more more things along the way. If we complete this, then we get this half of the letter. Okay. And at the end, we like having a big picture like a jigsaw puzzle. Last piece of the puzzle comes from it with

Miriah 43:51

Are you just making this up?

A. 43:53

Oh, yeah.

Miriah 43:54

Can I follow up with you some time and talk to you about what's going on here and the things you all are designing? You have time for that? Yeah. Okay. Great. Then I would stop.

Lorenzo 44:08

I would take a few steps back to the questions if we have time.

Miriah 44:14

Maybe about five minutes.

Lorenzo 44:15

Yeah. I was wondering like, how many children are usually in a class? Like the number of children.

A. 44:22

I'd say around 25? That's 25 up to 30.

Lorenzo 44:26

You said usually have a teacher and an assistant.

A. 44:29

If it's 25 and above? Yeah. Usually.

Lorenzo 44:33

And I was wondering, how's the classroom setting? Like, do they have individual desks or they combine them?

A. 44:44

It's very different, I think it used to be like individual desks. Everyone facing the teacher. And then it was like all together. And then it was like back again. So it's like, it depends, but yeah, but I think it's more like in groups like tables.

Miriah 45:01

like my son is they have set for tables and they sit around

A. 45:07

So for the teacher to reach everyone, there's now a common system is like you have this voice extender and voice like, speaker in the back for the teachers talking to a microphone. So those in the back hear as well as one in the front. That's a common system. And then they'll just make smart board, and they can zoom in on the texts and all that sort of stuff.

Miriah 45:31

So, wow, so different than when I went to school.

Lorenzo 45:34

And so they can rearrange them, eventually to make some sort of activity. Like, let's say, you need a big table for an activity, you can rearrange the classroom

Miriah 45:47

Would the teachers be willing to do that?

A. 45:48

Yeah.

Miriah 45:53

Because the kids have to get up and move and rearrange.

A. 45:55

Yeah, that's one way. That's one thing. As well as in the after school, whatever it is, or usually it takes place in the same same place and they arrange. Yeah. Now we were gonna play like it was just sort of creating a shift, putting on tables together.

Lorenzo 46:20

Do they participate in the management of the classroom? For example, when I was a kid, we used to prepare those big sketches and put them on the walls to make it more ours. Do they do that? And they have, like, specific activity, or it's just, for example, during this lecture, we did this paper, we could put it on.

A. 46:46

Usually that way.

Okay. Thank you, I'm really happy with it. Any feedback?

Miriah 47:02

Okay, so now the official, let's see, the end of the official interview would be, thank you so much. For the time, we really appreciate it. This kind of feedback is going to be really invaluable for helping, when I say us, I really mean, Lorenzo come up with something that we hope would actually be useful and exciting. I think we sort of agreed that, you know, we'll definitely point you, you know, he's going to finish up in May, we'll definitely, since this kind of feedback is really formative for what he's designing will point you to that work when it's done. If you're interested to see like where this went. Thanks. No, thank you very much.

10. Appendix C - T. and P. interview transcript

At 2.30 someone interrupted, interview continues at 2.55

Lorenzo 0:11

So what we're going to do now is to ask you a bunch of questions that are somehow divided in three main areas. Miriah will help me with time, but don't worry about it. Don't mind me reading through those papers. We just want to have an open discussion. So the first big topic is the schedule of children during school and places they spend time with. So first of all, how's the week or the day at school organized for students? And if they have a specific timetable for different subjects.

T. 0:50

Oh, yeah, we have a schedule for the switch, is the same every week. Yeah. We even have set like hours or minutes to each subject as well. I'm not gonna say how many because I don't know.

P. 1:08

But like Swedish, Maths and English are the the main three subjects.

T. 1:15

So if you want to talk about hours that you have, you generally have like, five hours Swedish

P. 1:22

300 minutes or something? A week.

T. 1:24

So you have like the main subjects that take up most of the time. Maths and Swedish. Yeah, really. And S.O.

P. 1:35

Those are the main four subjects. And then you have, like, physical education two times a week. And music once a week.

T. 1:53

Art once a week, but only in year four and five now.

P. 1:57

And then

T. 2:01

Textile and sewing

Miriah 2:09

My son is sewing a stuffed animal right now

T. 2:11

My son is.

P. 2:14

That's also once a week. Yeah. But for a longer amount of times. What?

T. 2:21

N.O. nature science. And they usually go from 8.15.

/ 2:33

T. 2:55

We were gonna say when are the start and finish roughly, everyday, it kind of varies, it's not the same. It's not, it's not the same time every day that they finished. So a lot of it depends on what lessons they have and the hours that they fit in. But may we say an average of quarter past eight?

P. 3:11

and until two or three o'clock, between two and three o'clock?

Miriah 3:17

And when you're running like a math section or Swedish section, like, Are you up in front, lecturing? Like our you know, our our sort of mental model is like a university course. Like, but like, what does it look like when you're doing a typical math class?

T. 3:35

Typically, it kind of varies a bit on which area you're working on. But if I take a general like a normal, like the most common, then it would probably be that I start the lesson with you like, what's going to happen during the lesson first, we'd like on the screen, you have like a digitally we have a digital smart board at the front. We prepare pictures and like numbers of what we're gonna do first. We're gonna do this, we're gonna do that with like pictures for those who need support with that.

P. 4:10

And also like the lesson's goal.

T. 4:12

Yeah, the lesson's goal.

P. 4:13

What's gonna be needed out of this lesson? Yeah. And how long time will it take? And what will you do after this?

T. 4:23

But this is also very important to know that this isn't all lessons. A lot of it depends on the teacher really. But Pauline, and I work like that anyway, because we have the same class. So we have the same structure to all lessons, is there anything else? That's usually how we start. Yeah.

P. 4:41

So it takes like, yeah, 5 to 10 minutes just to introduce the lesson. And then it really depends on a lot of it depends on what we're doing.

Miriah 4:49

I see, maybe some sort of activity that the kids would then have to work through.

P. 4:53

Yes, absolutely. It's never it's never like we're standing there for a whole hour talking. They're like taking notes. It does

Miriah 5:00

5/10 minutes of introduction and then eventually...

T. 5:03

yeah, generally we try to keep it like that because you lose him, you can lose interest.

P. 5:09

And if we're standing there like lecturing, you make sure that they are a part of it. Like, they take notes or they like, okay, they answer. Because otherwise they fall asleep 60% or five minutes later.

T. 5:31

because if you don't do that you risk losing, you're just losing them quite quickly. If you just if they just stay and listen, you need to engage them, they need to do work at the same time.

P. 5:45

And then both of us are like, we like to, or I think we both agree on that, like in the end of the lesson, we like to do something to make sure that have they learned or reached the goal of the lesson like a little, like exit tickets or Yeah, like to see or just like a hand raising? Or like, how was this lesson? just to make sure that it came through somehow.

T. 6:10

So you have like, you have a goal at the begin the lesson. And then at the end of lesson you like to try and, okay, have we reached that goal as which ones have reached that goal, which ones haven't? And then you kind of like assessing yourself sometimes as well. You want to know how that what I did during the lesson. Did it work? Yeah. That's so okay. Sometimes you don't have the time. But you know the goal is to do that every lesson. Yeah, make sure that they've learned that you want to come to. So that's the general structure that we do anyway . Many teachers work the same as well. From what I've seen, but there are exceptions.

Lorenzo 6:58

We'll get back to the kinds of activities but first, I wanted to ask, so you have different teachers for different subjects, right? Is there who like interdisciplinarity between the subjects? Do you try to combine subject maybe? Our networks? Yeah, we

P. 7:20

like there is a huge possibility to do that. Yeah. Because they're like curriculums are like, a lot of things are combined. And you can like do too, but like, for me, for example, this since I teach both Swedish and social science or so those work quite well to combine, like we can read stuff in Swedish that are about stuff we talked about. And yeah, for example. So that's quite easy to do. So it's easier to do it if you have both subjects. Yes.

But it's harder, because we don't really get to time to combine. Like, there could there's a whole lot of possibilities, but we don't have the time to do it. We don't have the time to sit down with the because I think like and though and so could be combined a lot. And like a lot of separate subjects can be more combined that we're doing at the moment, like

T. 8:19

a lot of us want to do it. I think it would be ideal. Ideally, we would like to do that. Because it's it will be ideal to work under a theme where every kind of like subject can come together and combine things. But he doesn't ask him anyways. It's hard. Because of time restrictions. Basically. We work a lot together, but not

P. 8:41

not with the same subject. No. But it could be like possible if we're talking about like, data collective stuff. It's good. Because in like, geography, there's like a part where you should like collect data from your like, near habitat or whatever you say, like engineer. Yeah, out in the streets or whatever. Yeah. Your near habitat. Yeah, like counting cars that pass by or something like that. And that's something that could like easily be combined with like maths and that kind of stuff. So just like, it just takes time. That's the biggest issue. Yeah, yeah. Because there are a lot of possibilities if you want to combine it.

Lorenzo 9:26

And I want to think now of the environment of the class. What's the classroom setting? Do they have like individual desk or do they move them around to do different activities? Do they used to work in groups, maybe on a bigger desk?

T. 9:44

In our classroom we have, they sit in pairs. And then when we work in groups, we can either move the tables around or what they usually do is they just turn around and work in a group together. Visual desk, If you're talking maybe like a separate desk that they go to? No. They work on Chromebooks. So they always have the Chromebook with them on the desk.

Miriah 10:17

What grade does that start?

T. 10:19

Chromebooks? My daughter has she got hers in second grade. No, first grade. She got her first.

Miriah 10:27

Okay, I have to ask my son. I didn't think at his school that he had them at that age, but I should ask them, interesting, sorry.

T. 10:34

it varies from school. Unfortunately, it does vary from school to school. It is very different depending on where you are. What's the town, you're in? Which area are you in? Also?

Yeah, they sit in pairs. Yeah, we do a lot of working in pairs, we do a lot of discussions. We try to make them active. We asked, we don't have many, like concrete material, unfortunately. But we try to make it how do we say? I lost my English word. Try to make it visual and things that you can touch as much as we can. But we do have enforced restrictions with concrete material. Yeah.

Miriah 11:27

Can you talk a little bit about the kinds of materials that you do have in a typical classroom?

P. 11:33

Yeah, what do we have? No, we don't really.

T. 11:37

It's a lot like cutting and clipping. Yeah, laminating and things ourselves. We are actually at the moment where we're trying to add concrete material to math to cover the scope. Because we don't have very much right now. But we are trying to invest in it but we have, we have like blocks and, what is it called in English?

Miriah 12:07

I'm sorry, thank you for working hard.

P. 12:17

Tangram? I have no idea, I only know how is it called in english.

T. 12:23

Tangram

Miriah 12:25

Things like for counting? Where different kinds of things represent ones versus tens.

P. 12:31

Yes, we have that as well.

T. 12:34

We have something called tangram, it's like you have different kind of forms and figures that you put together to create every kind of forms and figures. If you're working with fractions then we have like, almost like little pies that you put together to create different fractions, or this is an eight to six, you put them together.

P. 13:11

But it's mostly in math.

T. 13:13

It's mostly in math, we don't have anything else for any subject really.

Miriah 13:16

So just like paper, pencils ...

P. 13:18

Whiteboards

T. 13:19

Whiteboards. We use mainly pen, paper, computer.

P. 13:24

And then we like print out a lot of like pictures and they work

T. 13:30

together. You get different terms from different subjects. You have like the explanation, the word and maybe a picture. They try to put them in the right match them and things like that. Yeah, unfortunately, we don't have much concrete material to work with not at our school anyway.

Miriah 13:45

What do you wish you had?

P. 13:49

It could be like a lot, especially like in S.O. Like maps, those kind of stuff, something concrete to see something. And when we're talking about religion, if we had those kind of things to bring out something

T. 14:12

Like in math we need a lot in math. I want Lego, I need Lego. I need more blocks, and I need weighing scales and things like that we have them but we don't have the weights.

So it would help learning if you had a physical object that children can interact with?

Without a doubt, definitely. Because we have a lot of kids that need that. They can't learn without that. Unfortunately we don't have much. But it's not like that in all schools, I know schools where they have a lot of concrete material, they invest a lot of money into it. At our school, we haven't really invested in it, teachers want books. Textbooks and things.

Miriah 15:06

You want things

T. 15:07

we want concrete things that we can touch, move and play around.

Miriah 15:11

I get it, I guess that's your desires too

Lorenzo 15:13

Yeah that's the whole point of the project.

T. 15:17

When I look at these pictures, you know, it's like, I go gorilla with this, this looks great. I'm like, What is this? Can I use this in my class? I want to, you know, a lot of time you know, you need time as a teacher because things like this. You can probably, the kids can create it themselves as well. You know, you can bring the paper and the tape and the colors and you can create things yourself.

Lorenzo 15:38

About that, would you say that they would prefer to build their own objects to use or, like, like to play around with, like, papers and scissors and tape to build something? Or maybe they would prefer to use like Lego bricks? Because it's already made. It's just easier.

T. 15:58

A lot of it depends on the kid. Yeah, because you can't really put what put all the kids in one box because they're so different. All the kids are so different. You have kids that don't even like they'd rather sit on a computer or bring an iPad and move things around like this. And but we try to especially you when you when you work with S.O. and things, because I'm like I got sometimes you have like sentences or words that need to put them in order. And I'm more kind of like I cut them out and leave them but P. as I've seen you you like with English? Yeah, they cut out themselves so a lot more depends on the teacher.

P. 16:35

But they also like

T. 16:36

But thdy learn both ways

P. 16:37

Yeah. But a few of them wouldn't. They wouldn't. They wouldn't even touch it if they had to build it themselves. A few like that. And a few of that would be really excited. Yeah. So it's yeah, it's hard to say what would be, more or less, because sometimes because I did something with S.O. in this fall, but it was like, when they created a lot with their hands, and like build stuff for books, yeah. And the few like, loved it, they

were like, Can we do this again? A few years, like, no, refusing, was like the worst thing. So it's like, you can never make everyone happy. It's just ...

T. 17:15

because you're always gonna have like, like kids who just like to read a book and write you have the kids who like computers, you can have kids who like to think, yeah, kids who like to draw. And then you have like, kids who have difficulties like learning difficulties, they need this kind of things, they need to touch things and to move things around. So it's always going to be positive anyway.

Miriah 17:44

so you guys have to be very flexible when you're creating activities. And so ideally, your activities, yeah, allow you to have that flexibility for the kids. Do you want to talk about data?

Lorenzo 17:58

Maybe first the kind of activities they have. And we can move to data. Okay. So this is more second part of the questions. We were wondering, besides normal lectures like you were saying, do they have different activities during school, like we were talking to A. earlier, he told us that teachers tend to let children run a lot outside to keep them focused later during the lectures. What do you do during other times, not during the lecture?

P. 18:34

We've tried sometimes to have like, brain breaks, and that kind of stuff in the middle of the lesson but with our classes doesn't really work. They like lose it completely. If we have like, five minutes break, and then we're like, they're like no we're done. And then they lost it, you can't get them back. Like, then they're out. So we stopped with it.

T. 18:58

But I have done it. And it does work. Yeah, because I was at two schools before the school right now. And I've used brain brakes quite a lot. Definitely. Definitely. Especially, like during maths, so I've told them, they get a quick break from doing mathematics. So then you just, there's all kinds of different brain breaks where you can dance around or you can like, you can do paper, scissors, rocks and stones, you can like go like, where they don't just activate the brain, but they activate the body as well. So they move around.

Miriah 19:33

Do you think it's important that these breaks are very much removed from the activity they're doing? Or is it more about having an opportunity for kids to do different physical things versus passive things in the context of an activity?

T. 19:47

I believe that, I don't know what you think, but I like that I think that away from the subject.

Miriah 19:52

So they're really like a disconnect from the subject.

P. 19:58

It's a really short amount of time. 5 minutes, then it's out. And other than that, it's like we have, I don't know if like static counts some other activity.

T. 20:11

Yeah, those because it's it's not it's not the normal

P. 20:14

No. What does it called?

T. 20:18

value

P. 20:22

Work with value.

T. 20:28

With values, so you work with about being, like, being a friend, a good friend, using the right language.

Miriah 20:35

Yes, values.

P. 20:37

Yeah. So we have this like, theme in the whole. So as theme in the whole schools that we work is called So it stands, every letter stands for something. So we work quite a lot with that, that we have like different activities in the class to like, make them secure with each other and take responsibility, respect for each other a lot of respects, and to like use a good language.

Miriah 21:08

So do you try to incorporate those?

P. 21:10

Yeah, in every subject,

T. 21:13

You have, like, the letters are all around the school and in the classrooms. So you can so as a teacher, you can always refer to them, right? Subjects in certain areas.

Miriah 21:24

And is this just at your school? Or is this something that's pretty common across the municipality?

P. 21:29

Yeah, it's quite common, but it can be named a whole of different things, depending on which school

Miriah 21:34

you're saying the word is specific. Perhaps specific to your school?

P. 21:37

Yeah. Or you have them and but it's been like, ever since I was in school, there's been like, another word for like, was Charlie, was friends. It was Stark, but it's just more about values. And, like being creating a good atmosphere at the school and togetherness sort of thing.

T. 21:55

And then recently, we did the motion stop motion video, as well.

Miriah 21:59

Did you work with cinema?

P. 22:02

yeah,

T. 22:03

Are you guys are connected to them?

Miriah 22:05

There is a connection, please don't ask me what that connection is. But yeah, it is somehow connected. So you worked with the folks over there.

T. 22:14

Yeah. So they came to the school. And then we connected the stark, the values to the stop motion. So instead of just creating stop motion film, they had to like, create a scenario that has to do with values. Trying to create a stop motion video from that. Yeah. And they thought they really enjoyed it. Yeah, it was completely different from what they usually work with. Some kids took it seriously. Some kids kind of just thought it was funny and couldn't really grasp why we're using stark, this values things. Well, that was interesting activity.

P. 22:55

And there, you could really see that the kids today are so good with like, technology. Yeah. It took them like three seconds to just like "okay, I'll do this. And then I'll do that. And I was like "okay, yeah, you can do whatever" it was like, he didn't even have to show much, and they knew exactly what to do. That's really interesting to see how fast they learned.

Miriah 23:16

They were literally like creating the movie.

T. 23:18

Yeah, yes. Yeah. Oh, yeah. And what's really interesting as well is that the the kids that you would, that would normally find it difficult in a classroom situation. That's when they shine, because it's something totally different. And they can show that that their creativity and learn through creativity instead of being in a normal classroom environment. So when we're talking about things like this, so I always think about those kinds of kids the ones that have find it difficult in a normal classroom situation. It's these that's lets them shine off most often but not all the time there are exceptions.

Activities I don't know if you're not interested in breaks and lunch and what they do there. Yeah, I mean, it's just a normal things really. football basketball. They play King.

P. 24:12

which is like four squares where you should have like a basketball and then you should close to get this one is king, one is queens. Yeah, you're supposed to be bouncing the ball and another person, right?

Miriah 24:27

And then you get to move. got knocked out? Yeah, we call it Foursquare in the US.

T. 24:33

Yeah, I think we call it something similar to Foursquare or something. But I mean that we talked about data. I mean, that game is perfect. How about ball which which squared is the ball bounced in the most and how many times they bounced. Is perfect.

Miriah 24:49

So let's talk about data.

Lorenzo 25:05

What's their knowledge about it? Like, if you say data to the children what they understand what they think of?

T. 25:13

I think they think computers? Computer games maybe? maths?

P. 25:22

Yeah

T. 25:23

Possibly.

P. 25:24

You worked a little bit with that last year. It was nice. When you were sick. They might not know anything about it.

Miriah 25:33

They might not think that if you were out there recording the ball bouncing

T. 25:36

with no, they'd see it more as research. Gathering information. Yeah. I think some of them would not. I think we have some She speaks better english than me.

P. 25:57

Yeah. But a few might know.

T. 25:59

the majority wouldn't really. They know what,

Lorenzo 26:01

They don't make the connection. They don't see something they could count like

T. 26:05

no, I just think they think computers.

Miriah 26:09

Like the thing in the computer?

T. 26:10

Yeah, I think so.

Because we've not just we haven't worked with programming yet. We're gonna do soon.

P. 26:23

Some in like, technic. Yeah, they work with like computers and how they, like, collect data and that kind of stuff. Yeah, with a computer game.

T. 26:37

So data is definitely computers for them.

Miriah 26:41

So sorry, I'm just trying not to just ask all my questions. But so what do you as educators, what do you think is important for kids at, you know, grades four to six, at this point to know about data? Like, are there things that you wish that they knew, at this point? Or do you know, is it better for them to live in their bubble of data that's that thing in the computer? Like, what do you wish? What do you wish you could magically, you know, give to the kids as far as you know, them coming into these new data driven worlds we have?

P. 27:21

It's like, like, since we use quite a lot of information that is like, data driven, or like, yeah, they like use it every every day. And like, every everything we do, but they're not really still not sure about what it is like. So just to like, understand how it works and how it's, I don't know. It's just like, I think they would find it quite fascinating if they would know how it was because we like one time we do remember when we went to the statistic, like is *swedish words* thing. And we searched like how many people names like how many people are called this name? It was like the most spectacular thing they had ever find. It was like, Oh my God, they're three more with my name

T. 28:12

They got an extra 10 minutes because they were so excited about it. Baby names ...

P. 28:22

Anyway, it was all that kind of stuff. And like, and when we watched like, this is how many people we are in the world right now. And just like always increasing increasing increases. But there is still like people dying.

And like, that kind of stuff is really fascinating for them. Because they, it's so visual, like, if it's visual for them, they really understand like, wow, because if you say we're like 7 billion people, it's like, okay, but do you really see them like this all the time? It makes it? So just like, Yeah, because then that way, like visual stuff really helps them to understand something so not visual, so abstract.

T. 28:59

Yeah, it's like, the telephone. I don't I just don't understand how that works. I don't think they have any idea that everything you do. When you carry this around with you. I mean, data is collected constantly. Just for them to understand that is important, as well to understand that this thing that you have with you is like, records everything you do and how is that important? Why is that important?

Miriah 29:21

And are those ideas things that are currently being brought into the curriculum? Or is that still a challenge?

T. 29:28

Still a challenge, it's not so much data

P. 29:30

No, it's more like how you should be on the internet.

T. 29:34

Yeah, a lot focus on that. You gotta be careful.

P. 29:37

Yeah, you gotta be careful. And you have like, social. Yeah, you need to think about what you put out there and that kind of stuff. No, not really.

T. 29:46

It's really programming. Yeah. How to use the internet. Yeah. No, data is not really talked about. In math we obviously use tables and diagrams and things and we collect data. But it's not yet a really big area is quite small area in the curriculum years four to six. You always talk about that it's called data. This is data gathering data, they don't really focus on what data actually is.

Miriah 30:19

Yeah, isn't that funny? Yeah, I mean, even here, I noticed this, right? Like, you know, the Science Center is built, stories are built on data. But there isn't anything here that sort of tries to break down and explain well, what does that mean? In a way that I look, you always do this kind of thing. You know, someone can, like just even putting a definition to the word data is really difficult, which points to an interesting concept that these

kids have to learn. I think in order to be responsible, and also to be perhaps more in control of their own, you know, data that they're producing

T. 30:56

Yeah what they're producing themselves, exactly. Just when they go into the internet and search on Google, that's data. I don't think they understand that. Right? They don't really.

Miriah 31:07

Right.

P. 31:08

We also had, like, we were part of some kind of data collective thing. We're gonna answer questions about stuff. It was, yeah, we were chosen as the, because it was like the big class and every school in the years slow. And they had to answer like a whole bunch of questions, it would take around 40 minutes, or whatever they say it took like an hour and a half. But just like that and they asked, like a budget question was like: Do you have like a washing machine at home? Do you have like this, that? And they were just like, why are they asking us that? Why do they need to know that? Like, all that kind of stuff? And why do you need to know how many books I have at home? I don't know how many books I have at home. That was talking about like how, like, if you make sure other things happen, and yeah, so that was really because it's so abstract for everyone.

Miriah 32:04

Maybe not a few actually are going off and measuring something to track it in in your life. Yeah, very. So I'm just looking at the time. Do you want to ask more questions?

Lorenzo 32:18

Actually we already did the materials part. I wanted to ask if there's space for this kind of project in the curriculum. Is there some, some activity already going on that where this kind of project could fit in? Where like, for example, in math, where they could actually or in geography, you mentioned it earlier, that they could count something and visualize through the physicalization?

T. 32:48

In math, this all kinds of activities that we do where we gathering data. We've gone around like what's the most popular size of shoe in in the classroom? Well, who's the oldest? Who was born? You're gathering data there all the time.

Miriah 33:08

So you're already doing?

T. 33:10

We're already doing it, yeah.. But not really. But like I said, before, I'm not really focusing on data, and what it is. It's just working with how to use a table, how to use a diagram, not like, this is data, what is data? What can we do with data? So the focus isn't on data, but we gather in there quite often, in a lot of subjects. Regarding data when we evaluate how the lesson is gone, or how the week is, you know, you can use Google Forms to like, send out questions. How was your day been? It's been whatever, and then you get the data back. And then the evaluate the data. So we're kind of using it, rarely. I think, yeah, somehow. And then when we talked about tickets before to find out if they understood something? Yeah, they you you collect data, then but that's also collected, teachers collected data from the kids. They're not they don't collect data from each other that often, really.

P. 34:18

No, no, because then like, the only thing I can think of is like in geography, the thing I mentioned before, because that's like a part of the curriculum. But it's also part that I have a lot of trouble with, because I really don't understand what I'm supposed to do. I'm like, Okay, what should we collect data about? What's in our near area? Can we collect? It's like, the only thing I can come I was like, Okay, how many cars are passing our school every day like or something like that? But it's not like I think you could do so much more. But it's just like, we're quite lost and that's all because it wasn't really a part of our education as well that we learned, like, what can you do? Like, you put a lot of focus on the theoretical things If they're really practical ones, you don't really get any tools to use.

Miriah 35:05

I don't know if this is a really hard question to answer, but could you, would you be able to articulate like something? What is it? What would you love for your kids to know? About data? I know, that's a super vague question. I'm just, you know, I'm sort of imagining, like, you know, what, if you had all the kids, like, you know, you ask them, what is data? And they, you know, think about it, you know, whatever, you know, is it that, would it be good for kids to better understand that when you do these exercises, where you're talking about shoe sizes, or, you know, whatever, to make the link to, Oh, I hear about data and other contexts, and I can make the link between is it you know, having kids understand that, you know, they can produce their own data, or that they are, like, what around data would be really interesting that you would love your kids to understand

T. 35:56

Just that producing data themselves every day? And where it goes, where does the data go? What can it lead to?

P. 36:05

Yeah, like how our whole society is built on that? And like changes because of the data that are collected?

T. 36:15

Just what you buy, yeah, is affected by that you've given to them just by going into a website, or I think that's important

Miriah 36:24

Using your frequent shopper card. Stasis card at ICA, they always ask me.

P. 36:32

Yeah, stammis.

Miriah 36:33

I'm like, no!

T. 36:36

And like, that's important for them to understand.

P. 36:38

And TikTok as well. Because now with, with like the war in Ukraine, they're talking a lot about what they see on TikTok, and like, is this true? Is this true? And like, I've seen this from Ukraine, I've seen that and like to make them understand that, like, you're just getting these types of videos, because you consumed them before. And they noticed, like that kind of stuff. But they're like, notice, is this true?

Miriah 37:07

Recommended algorithms? They are everywhere.

P. 37:10

Yeah. And those really, I think they are really, because they they can't really cope with the fact that like, Okay, this is just because I watched a lot of these before, because now they think that because it was the same when when Russia was like close to Gotland, that there were a lot of military in Gotland. And there were so many, like students freaking out because they saw exactly because they're watching it.

T. 37:33

Because they may have seen it once. Yeah. And they saw it again. Because they've they click on it again, they don't understand that to click on it again, means that you can they get another video.

Miriah 37:42

It's not the whole world, it's your phone.

T. 37:48

I think that's really important.

Miriah 37:50

It would be amazing if you could do an activity that at the end, you can be like on TikTok.

P. 37:58

yeah, to make them understand.

T. 38:01

That's important to connect things to reality for them as well, because they have it, they find it really hard in all subjects to understand what we're teaching them and what they're learning in the classroom today is something that we want you to take with you outside of the school, outside of even when you're 18, 19. To use it in reality.

Miriah 38:19

Exactly

T. 38:20

That's also very hard. So data is probably is a way to connect the two.

Miriah 38:27

I mean, especially think about social media and these kinds of things. They probably don't think of that as school stuff. But

Okay, desperately we're out of the time. So if we wanted to do the last.

Lorenzo 38:57

what do you think they might be interested in looking to like, collecting data about? Would they be able to pick a topic on their own? Or it'd be easier for them to be guided through the choice?

T. 39:11

Maybe a mixture of two, like give them options? connected to their interests? probably that would be the best.

P. 39:24

I think there will be quite hard for them to not get anything to like go just like collect data, they would be like "what?" Because at least our students are not really like, what do you say?

T. 39:38

Self sufficient?

P. 39:40

They need a lot of guidance.

T. 39:42

Independent.

P. 39:43

Yeah, they're not really independent. And they also always want to make sure like, is this good? Is this good? I'm doing right? This is good? So I think it's too big to just like okay, collect data about anything. It has to be like, a few options but also to like have a flexibility in what to choose

Miriah 40:03

So some agency is important. But really, they need a lot of guidance.

P. 40:07

Yeah, I would say so

T. 40:09

to try and connect it to things they like, yeah. So that they would be interested in the data that collected could be important. Because that's what we, that's our goal a lot of the time to try and like, motivate them to want to learn. So you always try to like, find out what they're interested in and try and connect everything to that.

Lorenzo 40:35

And now, I'm presenting you a couple of concepts, you can have those.

I'm gonna explain them. But I want you to try to focus on the dimensions in the middle of the concept that we'll we'll talk about, and do not stick with the concept themselves, because it they're just broad and Super General is just something that we started thinking to start to figure out what could possibly be the solution. But nothing is already fixed, we can change everything, and we want to discuss with you about it. And there are two possible solutions for the toolbox that I will create. The first one is a toolbox and activity, thought to be at children's homes. So when they get back home from school, it's like a homework for them. We would

have a couple of guides, one for the teacher and one for the children, for the teacher to help children through the project to guide them to be the facilitator of the activity. And for the children where they are home alone so that they don't get lost in something that might not know. It would be an individual activity. So each child would choose a topic theme that they like. Of course, as you were saying, with the help of the teacher, because it might be hard for him to pick something out of nowhere, the material they would use would be the same for everyone. So that we would reduce the effort of creating something out of scratch. So for example, it could be Lego bricks, so that it's the same for everyone. And it's everyone, everyone is using that it's the same for everyone. And at the end of the activity, of the of the process, we would have an exhibition in the classroom, where kids could explain what they have been collecting data of what the story behind it what they wanted to say or to explore with the data collection. On the other hand, other toolbox is, is the activity is taking place, in schools in the classroom. And so it's a group activity, they do it as a class or as smaller groups within the class. So that they can take decisions together, but they as a whole class, but they would still have the guidance of the of the teacher. That's why we would still have the guide only for the teacher this time to again, just like the previous example to guide them through the whole process. So the teacher would know what to do and what the next step what's next. It could be potentially related to a topic that it's been treated in school, some specific subjects math or geography maybe. So they don't, they don't need to think about something new, but they already have it. And they as a class, they know what it is. Yeah. It could be like this assemble a group game so that it's more engaging and finding product. And in this case, the materials will be suited on the on the project, they will be tailored for the specific project. So they get to pick a specific materials for that specific purpose. As the previous one had to be at the end of the activity, there will be gather around but this time it will be with a shared board in the classroom, probably the same that they were that been working with for the whole process. So they're working on the same together on the same board. And at the end of the process they had they would have the result of it. And it's a way to get together around that. until about the last day what we learned about it, what's the insights from it?

Miriah 45:08

So we should stress, these aren't like one choice or the other. They're just hypothetical.

Lorenzo 45:21

Are those clear? Or do you have any doubt about the concepts?

So I want to try to start a conversation about the different aspects of it. What do you think like, let's start from the beginning? Is it better for them to have a group work at school, or maybe to start at school and then going on home as an homework?

T. 45:45

I think you would definitely need to introduce it in the classroom. Yeah, first, and then maybe with the aim of a day, they could do it at home. Because you would kind of like, need to instruct them as to how it would

work. Because they can't, you can't just expect all the kids to be able to do it by themselves and to choose their own and do it individually. Some kids maybe can't even do it individually, they'll they might need to work in the classroom not at home, depending on ...

Miriah 46:28

is there is would there be sort of time and space in your sort of typical school year for an in class activity? Part of I think our question is like, how hard would it be to design something that teachers could actually work into the classroom versus something that might be extra that would be took at home.

P. 46:49

If it's easy to connect to a subject, I think there will be a whole lot of possibilities to use it in the school. And if like, if you know, if you know it in advance, as a teacher, it's like, it's easy to get something in, it's not like, No, it's not like hard to put new stuff in the year, like most of us really open to try new things, as long as you know about it for a long time before and it sounds like Okay, so next week, we're gonna do this. Like, that's not really the favorite. Sometimes we have done things like that. It's like, okay, now you're supposed to do this. It's supposed to be next week, and you teams all plans and you're like, okay, yeah. But as long as you have the time, it doesn't really matter.

T. 47:33

If you can connect it to the subject, then it's not a problem at all. Because the main thing about being a teacher is not what you learn, it's how. So like, it's always up to you, the teacher: how do we learn about data, and as long as it's connected to a subject, you can always fit things in. That's how we work with, like problem solving, or mathematics or programming in mathematics, you can always connect it to things as long as you prepared and a lot of the time he does have to go in the classroom first. Working at home is very different. Yeah, very different to working in school with things.

P. 48:11

And this depends on what school yeah, like in our school, we cannot count. We're like, we don't really have much homework, because we know that like 40% will never do anything. And 40% has never even returned homework. Because they don't get any help from like parents and that kind of stuff.

T. 48:30

Our school is situated like that, you know, very, say the socio economic status in the areas quite low. So they don't love it, they don't really get much help.

P. 48:43

So in that way, I would say that the school yeah.

Lorenzo 48:47

It might be hard to do it as a homework. Would it be hard to involve parents as well?

P. 48:54

Yes.

T. 48:55

Our school? Yeah.

P. 48:56

And another school could be like, yeah, you can get a whole lot out of having that home. But no.

Miriah 49:07

What about the idea of kids working in groups versus individually on projects? Like, how does that work in your classroom for activities?

P. 49:20

Yeah, but still works quite well.

T. 49:24

Any, you know, as long as you create, like, three group, safe group that's comfortable working on each other? I think our classes work great in groups.

P. 49:36

Yeah, because they, because you will always have like a few that are really like lifted up by being in a group with other and need the support of others to work. And you have a few that really, like, needs to also calm themselves and like talk to others. And so it's quite good to work in groups as well because it helps them in other ways and Like a few obstacles that that you as a teacher will would find if they were individual. You don't find if they're in groups because they will help each other.

T. 50:08

And then you try to like create groups where they help each other. We don't just randomly create a group, you try to make sure that you have maybe some key students in certain groups, the others who need some things.

P. 50:26

The only thing that would be hard if they do it in groups, it might be like, if they're supposed to choose their own, like subjects.

T. 50:34

They might argue

Miriah 50:38

It sounds like you've already also said that it would be good to have maybe a limited set of options. And I know, You've brought up this, this sort of entertaining, you've sort of labeled versus didactic. Gamification.

Lorenzo 50:57

The truth always sits in the middle. But do you think it's better to have a more deductive, didactic and educational activity or other since they're doing it in group, more fun activity and more entertaining?

T. 51:13

I think both

P. 51:19

It's hard, because sometimes when you do like really fun, fun things, or whatever you they don't really see what is behind it. You're like, oh, I have no idea what we did. It would be like, Okay, did you learn something? but they like they always learn something. Really, they can't really see it themselves, what they've learned when it's too funny.

T. 51:39

No, because focus is always on the game side instead of actually thinking, but that's our job to try and make them understand. And we always ask them, Why do you think you've done this today? Can we connect it to what we've worked with? But that's when you genuinely see. Yeah, a lot of them haven't really thought reflected over why they did it means about the land. So didactic is always the winner for me, but things have to be, for a lot of kids, things have to be entertaining. They got to be entertained, also.

P. 52:17

I think entertaining, it's also more about making it like engaging and like, they're, they're a part of it, because then they think it's fun. But it's not supposed to be like funny. Like, I don't know if that's

T. 52:30

But you kind even like learn a lot. Yeah, yeah. Why don't they need to be motivated and interested in the need to be entertained? Then you have them, then you can teach them things. That's kind of the goal for me as a teacher to train. And it's helping them get them motivated first, and then there comes the bomb.

Lorenzo 53:05

So the guidance of the teacher would be definitely important, they would need that.

T. 53:13

Very important, critical

Lorenzo 53:15

Would it be hard for them to just be free to explore something? they need boundaries.

T. 53:21

Yeah. And I also think this the same in all schools, really.

Miriah 53:27

I guess we all imagined our children as like these, like, creative people going in the world doing their stuff.

The reality is actually ...

T. 53:37

Well in the accurate, they need to be creative, they need boundaries, for them to be creative. Because if you don't set boundaries for them, then they the focus is completely wrong. You need to create the boundaries for them to understand, like, you can be creative here in this little boundary here. You can't come outside it because that's when you lose focus.

Miriah 53:57

I think adults are like this too.

T. 53:59

Yeah, definitely.

P. 54:01

Yeah. We have too boundaries.

Lorenzo 54:08

And what about the two different outputs that we have? How the two would, what benefits they would bring like the to have a shared board or to have each child to tell something that is personal. What do you think the pros and cons are there?

T. 54:32

Exhibition is kind of like more, I think where when you you're kind of talking about like a presentation.

That's when you're talking more about, they get chance to speak about what they learn and reflect and what

they're, why they do things and what happened and the result of what they've done. So more the kind of cognitive side of things like what I've learned when I'm doing this. Class shared, classroom shared board? I've not really worked with that. Like, we have one board where everybody don't really, we don't really have an experience, you know, I don't know how our kids would ...

Miriah 55:16

If you had this thing that existed whether it's on the wall or on a table that people contributed to with, could you imagine kids sort of passively engaging in that?

T. 55:28

Yeah, I think so.

P. 55:31

Yeah, they might.

T. 55:34

The exhibition is always, yeah. So now you're going to present what you've learned, kind of things, maybe this classroom shared board is. So when you finish, here's the board, put the things on there, what you've created there so that we can all look at it together,

Miriah 55:46

Also as they're creating

T. 55:48

they're filling the board. That's also sounds interesting. But I've never I've never worked with that.

Lorenzo 55:54

Maybe could be a mix of the two like, yeah, working in smaller groups, each group could work on a, let's call it a board or paper and then present to the rest of the class.

T. 56:04

Yeah, definitely.

P. 56:09

Because we haven't, we don't really have much space to do it. We have like windows all over the place.

T. 56:15

Really anywhere where we could have it, for example.

Miriah 56:19

So space is a consideration.

T. 56:21

Yeah, again, it depends on the school again.

P. 56:23

Yeah. It's also like, because we also learn that, like, we shouldn't have as much like things in the classroom, because there are a lot of students that gets distracted if there's nothing going on. So it's like, weighing pros and cons, but having to

T. 56:38

I think a digital classroom, a shared board would work. Because you can create like presentation, different sections, where the kids can put their presentations on a bigger presentation for the whole class to go and look. So digitally would

Miriah 57:01

Sorry, I'm just constantly in awe of the things that you describe that your kids are going to do. And I just think about my child. Like, I can't imagine him doing those things in a year, but

P. 57:13

It will be fine. I didn't see it happening when we got our students either. There's still a lot of stuff not working, but we're hanging in there.

Miriah 57:32

I have one last question. Yeah, go for it. One last question. So okay, so if you had your magic wand, and you could magically produce some sort of activity on data, whatever, what would be really magical about this thing? Like, like, what, what makes what would make for just an amazing activity? And it's very open ended question. But like, what, what's your like? Wish? what's what? What do you wish for in something that Lorenzo might be able to create?

T. 58:03

So yeah, I think straightaway about mathematics, this could really work in maths, you could connect it to lots of different areas in mathematics, gathering data and producing graphs and tables and then relating it to everything to addition, subtraction, multiplication, fractions, you can you could connect it to anything really. What I think a lot about is the students that we have that don't really have an interest from us, they don't really think, they don't really know what it is. They just think it's something you do at school. So I kinda like

tried to have a lot of kids that like football and things and that they could go and research different football games at home. How much what percentage ball possession did they have and what you know, how many shots did they have and gathering information from the games and then they come back to the class and present what they found in this game there was this in this game what happened? In this game he shot seven times, scored once. That really can connect percent to that and everything to

Miriah 59:09

You're surprising them.

You're doing math!

T. 59:10

You're doing football, what would you say when you watch these games? Look, data has been produced all the time. Even when you start watching the game? The How do you think they get all these figures about how many times have touched the ball? And this is all going to be a lot of kids interested in, in doing research about. They're interested in at home and bringing it to their research something at home, and bringing it to the classroom. Giving them the options, what would you like to research? But you'd have to explain data first and what data is, what are we talking about? That'd be a big quite a big subject. But you could work you could try to connect other things to it quite well, but I'd like to give them like, like research something that you're interested in, talk about research and data and how it works. Go home and research this, take notes, write down, bring it to the classroom. What have you found? What does this mean?

Miriah 1:00:18

That's actually, then I want to hear about your magic wand. It's one of the things that we've talked about some is that I think is so critical to to data work today is how you go from something you care about in the world, to what I call operationalize, but how you go from that to something you can measure, right. So you say, I want to know, who was the best player last night on that football game? Right? Like, well, there's, there's no one thing you measure that says best player, right? You have to make some assumptions like, Well, okay, what is the best player? Me? Or he touched the ball on or you saved a lot of balls, right? And then that sort of that process of having something you want to know about the world? And then working through Well, what can I actually measure? That might help me answer that question? Like, I find that deeply interesting. And I also think that like when I mean, I work with like adults all the time, like people who are working with data. And for adults who are in fields where they're not like naturally data, heavy fields, that process is like really hard, like thinking about how you operationalize stuff. Anyway. So that's what I've also been interested in. But I don't know, we've talked like, What age are kids capable? Like? How would you even help them? Do that process of saying I care about football?

P. 1:01:40

I think it's quite hard for them to make assumptions about how you like, okay, so you're interested in that? How should you now ask the questions, right? Like, that would be really hard if it's something like, who's the best football player, but if it's like, something easier, or more narrow, they would be totally like, because that's like a good really good task to just like, okay, so we we want to know this right? What questions should we ask them? Yeah, like, that's a really good because now they're starting to understand that whole thing.

T. 1:02:14

Yeah in year five, year six, yeah.

Miriah 1:02:16

I mean, that you were you know, you were mentioning research. I mean, this is like hypothesis generation too. Yeah. My hypothesis is that this person is the best player, how are you gonna find out? Are you gonna find out?

P. 1:02:29

Because that kind of stuff. They work within, like, natural sciences, like hypothesis and like, what will happen here? What will happen after that?

Miriah 1:02:36

And they do some of that in grades four to six?

P. 1:02:38

Yes.

T. 1:02:39

I think they're definitely ready for this kind of thing. Yeah, definitely, grade five. Yeah. When they started... Yeah, definitely. I think this is definitely something that you can do, grade four.

P. 1:02:50

As long as you give them specific a lot. Yeah. There's always like, you can teach them quite a lot, as long as you build it up a lot of like, yeah, creates like a firm ground to stand on.

Miriah 1:03:03

So what would you create with a magic wand?

P. 1:03:06

It is hard. But like, I really liked what we were talking about before with the whole, like, making them some sort of understand how the world is built up by this whole data collecting thing and how it everything we do

and everything is affects, everything. And if we could create, if you could create something that, we here, now we're part of this, but if you could create something that would make them understand and then you could use in like so many different subjects, subjects, and they wouldn't be like, "okay, it's only when you're in mathematics. And it's only in that.". If you could, like, connect it to all the subjects I think that would be really, like powerful for them. Because they because I see often that they have trouble understanding how subjects connect to each other and like, the world is connected. Yeah, like, if so much trouble is like "okay, now we're here" and then if you like, go into mathematics, is like "no, that doesn't exist anymore. Now Swedish doesn't exist. Now, when when I'm in the mathematics or natural sciences", like all of that, like if they would have something that will help them connect the world together

T. 1:04:14

to reality. Yeah, like it's really upon as well through the subjects onto reality, because I think that's the problem as well. They don't really understand a lot of the time you have to drill into them, like we worked with being clever with the angles in maths and I tried to, but didn't really understand like, what what why do I need to know what about 90 degrees is? how can I use that? So it's like well, you know, if you build things and it needs to be

Miriah 1:04:41

See you have to help your dad put new floorboards on 45 degrees.

T. 1:04:47

Like you know, these people that build bridges, civil engineers and things how do you think they build things? they can't so I wrote like, I drew a picture of a bridge. The bridge look like this. This will work. Like no so here you need to use here. Yeah, the protractor?

Miriah 1:05:03

protractor. Yeah, I guess, like, measure the angle. Yeah. It's so interesting that so you're sort of talking about this challenge of taking these sort of pedagogical concepts that you're teaching, and helping the kids take that leap into seeing that in the world. See why that knowledge, and you're right in that regard data, data is such a natural sort of catalyst for many of those things, because it underlies so much of what we experienced day to day.

P. 1:05:29

And we always, we talked about that quite often. Like it's not, it's not about teaching them, like specific facts are like, because today, you can like look up anything, it's about learning them how to learn things, and how to work in a world. Yeah, and when you have, like, a lot of data, just like in your phone, and you can find anything, but just like, make them work the best way possible.

Miriah 1:05:55

Totally.

T. 1:05:56

Because it's moved on, time has moved on. Well, we've learned about facts and things. You need to understand how things work now and how you can affect them.

P. 1:06:05

And it's a really, yeah, it's a challenging time to, for them to grow up. And like, it's so much data everywhere that like, everywhere, and how to like, sort things out and just like in to be able to sort things out, you need to know what you're...

Miriah 1:06:20

You first need to say something about what data might be.

Your project is gonna change the world!

Lorenzo 1:06:27

Nothing is gonna be the same anymore.

T. 1:06:33

Or are we completely destroying it?

Miriah 1:06:38

I feel like I've had just so many ideas, like so many things that we have not even thought to consider has come out? No, at least to me, in this conversations.

P. 1:06:48

That's good.

T. 1:06:51

a positive way, hopefully.

Miriah 1:06:56

Some ways, I, you know, the research I do is always quite collaborative. So I do a lot of applied work, where I work with, like, people who have data in the world and design tools with them. And then, you always, then you enter in with this perception of what people need or whatever. And then you start talking with them. And then it just explodes into this world of possibilities. But also, you realize just how many things you can

do and the importance of needing to find some sort of nugget to scope, which I think is going to be your next challenge. Right. But I think this has been incredibly productive for us. So I don't have, did you have anything else you want to talk about?

Lorenzo 1:07:41

Just one quick thing, you were mentioning, like you tried to think of combine, not combined, but how subject might be related to each other? Don't you have like, for example, last year was 100 years of the democracy in Sweden, don't you have something when like some special event comes that might connect the different subjects? Like some special projects or...

P. 1:08:04

The thing is that we really could do that, but we don't really, but it's like, our school is quite a new school. Like it hasn't really worked up its traditions and how to do it. I think there's a lot of schools that have always had like, okay, so...

T. 1:08:21

Like when the minister comes on, yeah

P. 1:08:24

Like the United Nations, what is it called, day in like, October? It's like always F and where you're, like, put together to talk about

T. 1:08:34

everyone works under the under that thing? You know, that's very popular and common, but like P. said, it's quite a new school tradition wise, well it's not a new school, but there's new principles, and new, new teachers have come and the traditions aren't there anymore. We're trying to start a tradition.

Miriah 1:08:55

You don't have this like legacy of what's been done in the past to sort of lean on.

P. 1:09:01

So we have to create it from scratch. Yeah. But it's absolutely it is. And like a lot of I think it's also in like higher grades. We'd like to hold democracy thing. Like that's a really big part. And it shouldn't be more like themes, because it can be connected in so many ways.

T. 1:09:18

I don't know how many times we sit there and soon it's the International Women's Day.

P. 1:09:23

Yeah.

T. 1:09:25

Come on, let's do something. But it's like there's no tradition. Yeah, you need the time to sit down with the colleagues and plan and because you'd love to create a week where everybody works with the same theme.

P. 1:09:36

Because there's also the possibility for them to understand how the world connects together. But now we're like, starting with pushing it away, since we're always like, Okay, now it's this, now it's that. Yeah. So it's like, we're pushing against ourselves.

T. 1:09:50

But yeah, but I mean, it's like, the idea. Well, that's what we want. Yeah that's what a lot schools do. A lot of schools do have it. But we don't have it unfortunately. And then a lot of it depends on colleagues as well, which colleagues, some colleagues don't want to work, don't want to collaborate. Some colleagues, I've worked for 30 years, I know what I'm doing, and you come with new ideas, and they will be scary. So you can fight in a lot of time against colleagues as well. But in the ideal world, we'd all like to work in the themes, every subject, because that's what you want the kids to understand. You want them to understand that you can use this in maths, you can use this in so everything's connected, because it's the world we're talking about. We're not just talking about math, English, we're preparing you for out there.

10. Appendix D - Teacher's guide

The following is the guide that accompanies the toolkit as it is present in the final project. It is supposed to be printed on an A3 sheet, which folded in two forms four sides in A4 size, as presented in the digital version.

It is recommended to print the guide for better use, as some texts fall on the fold of the sheet and are difficult to read on the digital version with the view set on a single sheet.

DATA BRICKS SPACE MISSION

TEACHER'S MANUAL

Age: 10-12

Setup time: 40min

Play time: 1-2h

1 INTRODUCTION

Hello teacher, your class has been chosen for a special mission in space to meet aliens and you will be the Captain for your little rookies!

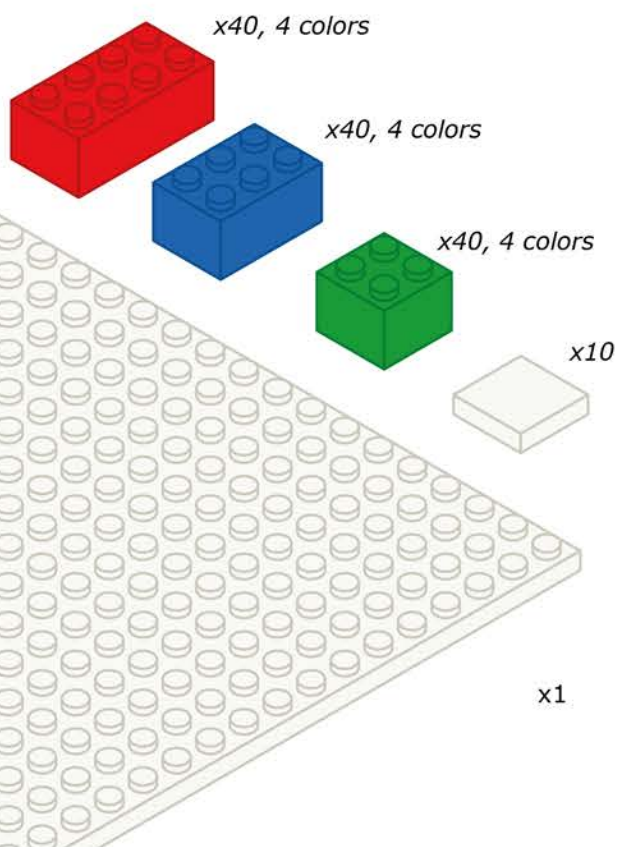
This kit is intended as an aid in teaching the collection and interpretation of data, intended as qualitative or quantitative information that represents a specific phenomenon. Through a fictional story about space, children are asked to solve specific tasks which involve collecting information about a topic from the curriculum, using the Lego bricks provided as a metaphor for data.

You are about to face an expedition on a high-tech spaceship and your team's role is to get in touch for the first time with aliens. Like any spaceship, there are different modules and each one brings with it an exciting task!

Can you feel the classroom turning into a spaceship?
Let the adventure begin!

2 COMPONENTS

For every session, each team will need a Space Toolkit. It contains a class/spaceship floor plan (see section 3) and a toolkit for each group, consisting of the following: 2x2, 2x3, and 2x4 colored Lego bricks as tokens to represent data, white tiles to write the title of the task, and a white base representing the clipboard on which to collect the data. Add sticky note pads to the kit, they will help students take notes.



3 SETTING UP

If you feel lost about some points, don't worry! There are some examples later in section 4.

Choose a topic

The toolkit is suitable for tackling single subjects alone as well as a single theme that involves several subjects together. As a teacher, it is your role to pick a topic that you feel might be interesting for children and for educational purposes. A good topic is something that children can grasp, about which they can gather information and find data that is countable and can be translated in quantities and qualities, making them discover or understand a story or a topic they did not know.

Formulate the tasks

You have a topic, now split it up into some simple questions that children might be able to answer through the collection of some data. You want to look at something that children are able to collect, count, and analyze. Try to connect the question to the story, so that it makes sense within the context of the activity. Children should be able to find this information in the school material they already use in the curriculum.

Build the spaceship structure

As in all spaceships, there are several rooms and you are in charge of choosing how to organize them. Attached to the guide, you will find some figures of rooms that you will cut to create a floor plan. With imagination, each room will be represented by a desk in the reality of the classroom. There is a big main room, the spaceship's Command Room, around which you will go to arrange the other smaller rooms. Each small room corresponds to a mission task that children must complete by collecting data on the questions you have chosen. Once you feel you have the right structure, translate it into the class arrangement: organize the desks in order to reflect the position of the spaceship's rooms. Place a large desk in the center of the room and the smaller ones all around. The floorplan will serve to present the location to children and direct them to each mission.

Prepare the material

Each task might require a different source of information for children: a book, a computer with internet, etc.. Make sure whatever they need is ready and place it on the designated desk for that task.

Make teams

Divide the class into at least two groups. You might want to have one team for each task, or have fewer teams than tasks and let them perform more than one task. Try to compose teams based on the abilities and characteristics of individual children to have a good balance.

4 THE SPACESHIP FLOOR PLAN

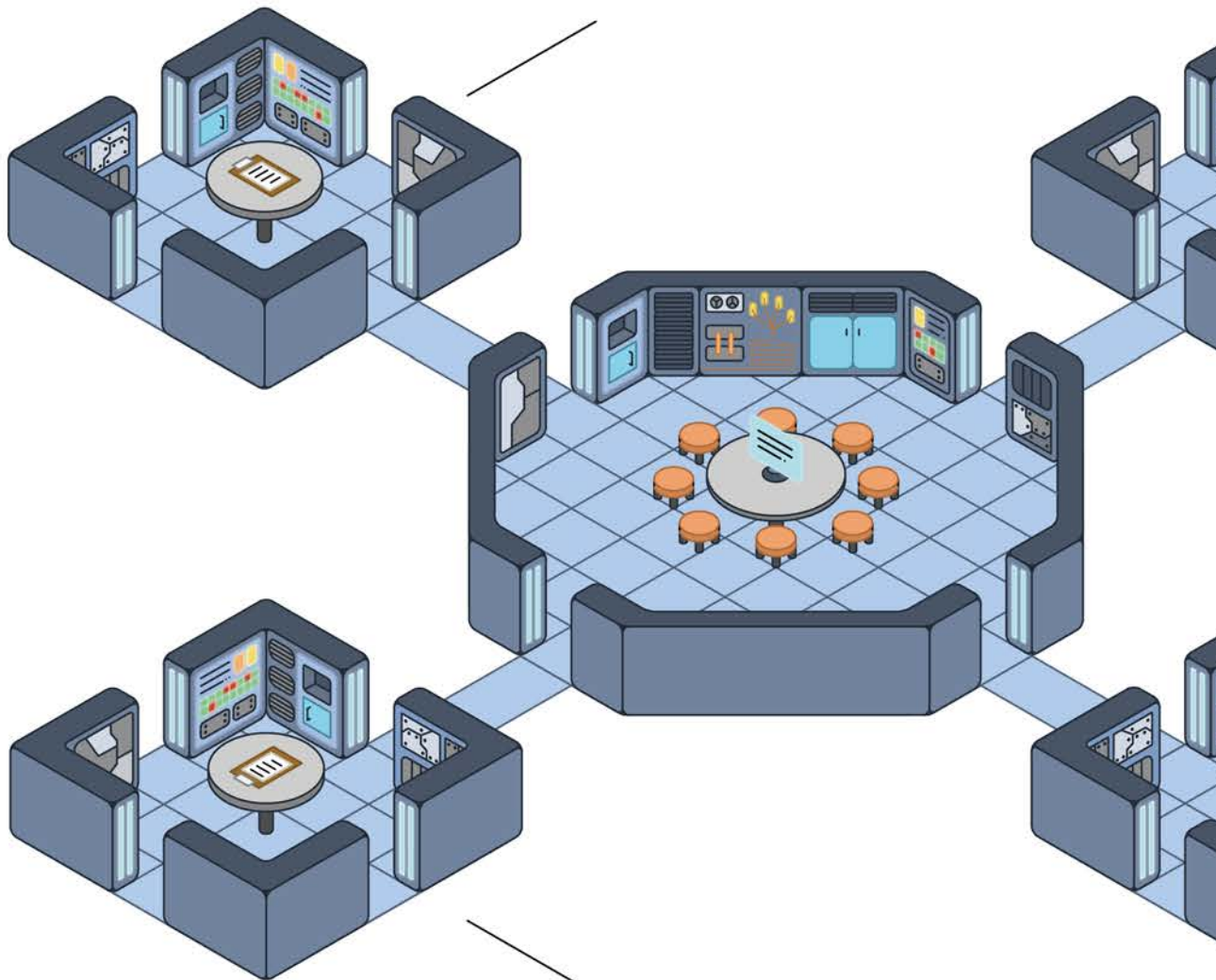
Below you can see an example of a floor plan with five hypothetical tasks and their rooms. Those are just to provide a clue of what kind of questions might be suitable for this activity.

Be creative, use your imagination and create new adventures for your students!

GEOGRAPHY

Aliens are really curious to meet humanity and would like to meet all the people of Sweden!

*Where are Sweden's twenty largest cities located?
In which region might they meet most of the people?
Count how many large cities there are for each region
and compare them with each other.*



BIOLOGY

Some of the aliens are flower passionate, they have all shapes and sizes on their planet! They would really like to discover ours too!

*What are the most common? What are the most recurring colors?
Go to the courtyard and count as many as you find!*

ENGLISH

Aliens are trying to communicate but they can't speak your language! Try to find something to say, or they might misunderstand something!

Grab this book and find out which are the four most used words! Count how many times is each word repeated. Which one has fewer characters?

SUSTAINABILITY

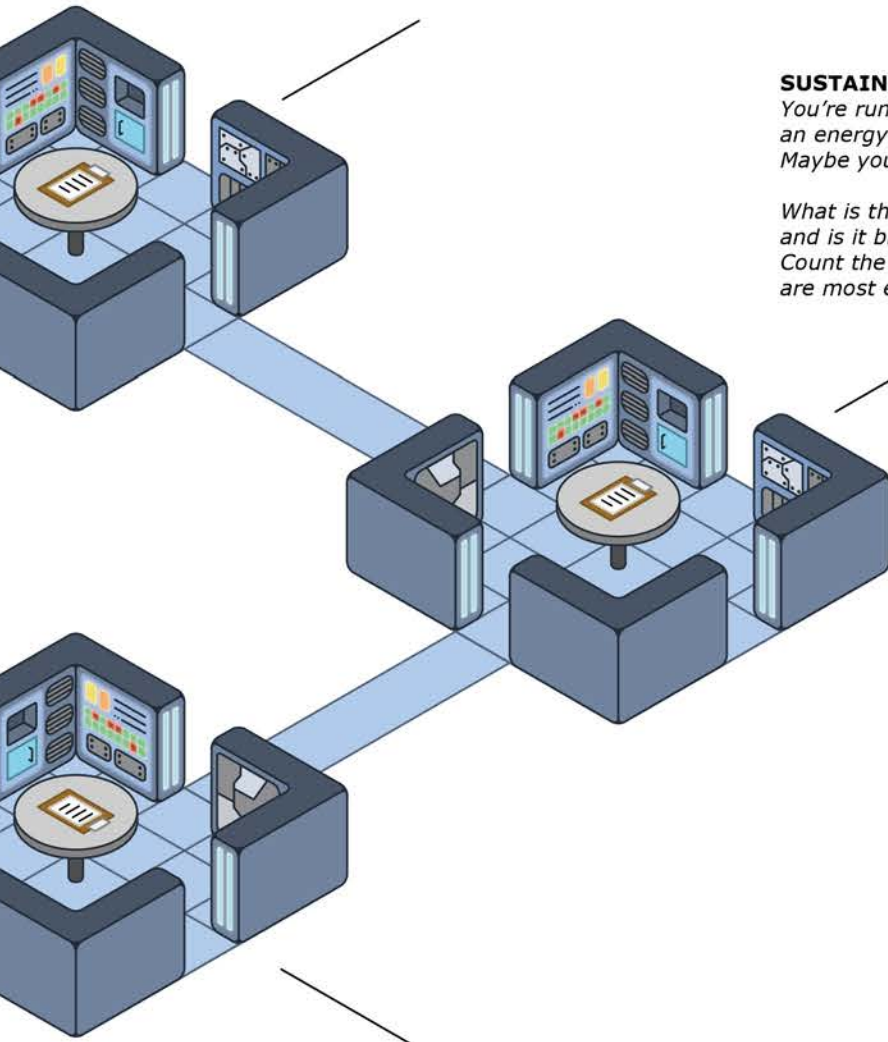
You're running out of fuel on the spaceship, you may face an energy shortage if you don't find an alternative soon! Maybe you could use solar energy?

What is the point with the most windows in school and is it brighter? Count the windows in the school and see which ones are most exposed to the sun!

MATH

To face the aliens you need to know the characteristics of your teams well!

How tall are you all? Who is the tallest? Measure yourself and calculate what is the average height of the two teams



5 LET'S PLAY!

Introduce the toolkit

Present the activity that you are going to perform to the children. You are telling a story you want children to feel part of it. You'll perform the captain of this Spaceship, inviting the kids to follow you as brave little troupes in an engaging role-play. Believe in the story so that children will believe in you. Introduce the toolkit to them: what are the components and how they can be stacked and combined. Tell them how to use the kit: the bricks are the representation of qualitative and quantitative data, the main base is the clipboard on which they collect the data, and the white flat tiles are meant to provide a title to the clipboard. They then have three different kinds of bricks in four colors to represent the data they discover. Explain it without mentioning definitions or theoretical concepts that might bore or confuse them.

Define the goal

Present the different tasks to each group and set a goal they have to achieve through data collection. Write the title at the top of the clipboard through the small white tiles and a whiteboard marker.

Set a brick grammar

Guide the children in choosing what each brick represents of the data. Help them find a link between the types of data they can find and the different shapes and colors. For example, the three sizes of Lego bricks can represent units, tens, and hundreds. They can be stacked, organized by color, and sorted by size on the clipboard that function as a base. You don't need to use all of them, as well as you don't need to try every kind of combination between dimensions and color. Write down a legend on a sticky note and attach it to the inside of the Space Toolkit.

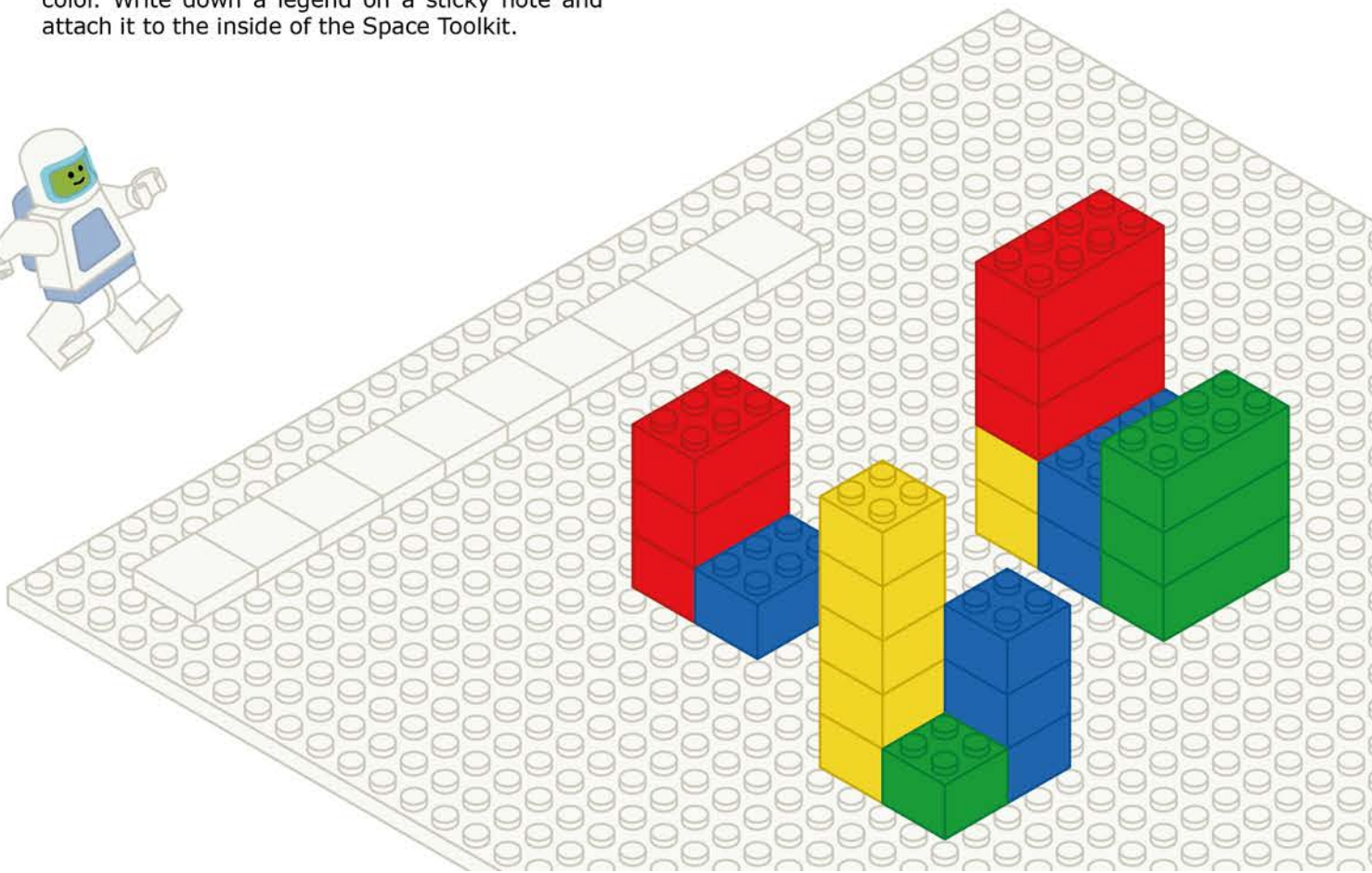
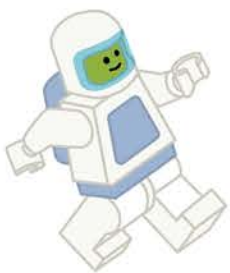
Guide them

You are the main facilitator of the activity. Provide some guidance on things you imagine might be hard for the children. Ask interesting questions and help them notice something they're missing. Help them understand what information they are looking for and how it can be counted and translated with Lego bricks. Support them through the process by answering their questions or suggesting clues if they get stuck.

Conclusion

Once all the tasks are completed, gather the children in the Command Room and let them present their findings. Try to foster the discussion with questions and observations that make them reflect on the data they represented on the clipboard.

What do the bricks they employed represent?
How did they organize them? Why?
What kind of information did they collect?
Explain that the bricks represent data that they collected.
How did data help their mission?
What other kinds of data might they have collected?



 **CUT THESE OUT!**

