Working with Statistics in Kindergarten: A sustainable Approach

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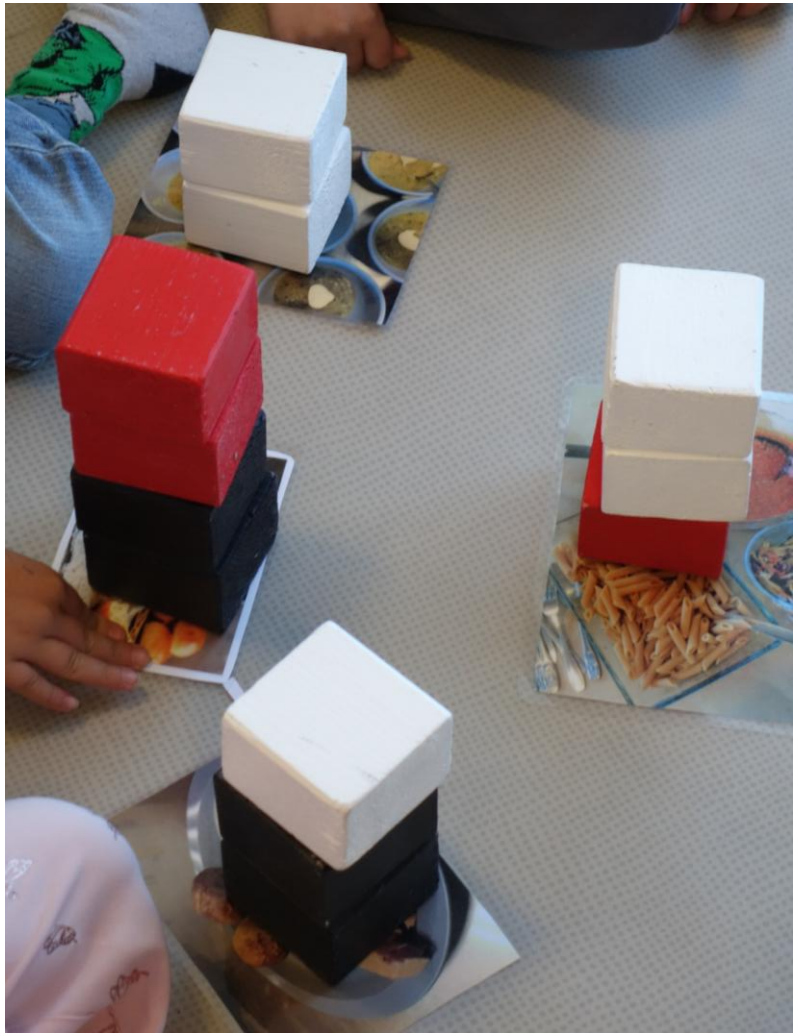


Background for the study

This study explored **sustainability** as its central theme through a collaboration with a kindergarten. Each person has the potential to contribute to sustainable development ([8]; [9]). However, **altering habits** requires time, making kindergartens ideal starting points for embedding sustainability-focused practices early on.

The kindergarten involved in our study was *a health-promoting institution*, adhering to criteria from the "Eighteen Thousand Hours" project ([2]). Two pertinent criteria include following *national dietary and nutrition guidelines* and integrating *health-promoting initiatives* into their management documents, quality systems, and daily operations ([2]).

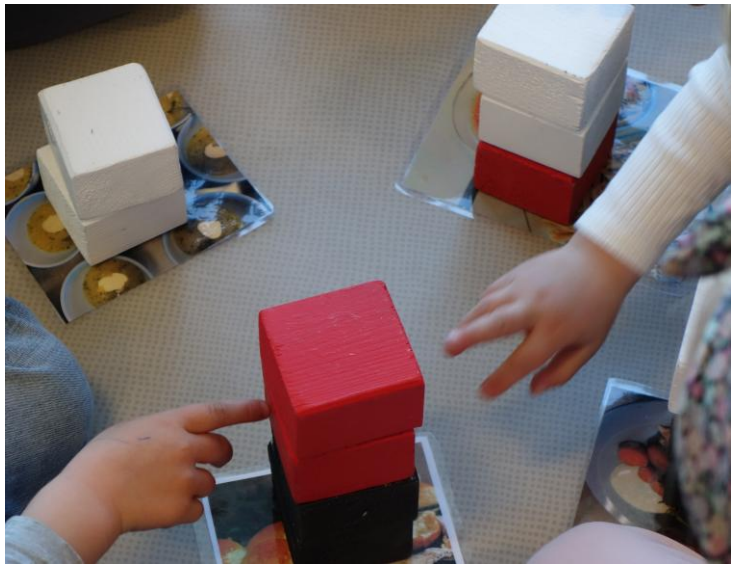
In the kindergarten, **statistical work** is integrated within the domain of *numbers*, *spaces,* and *shapes* outlined in the Framework Plan for Kindergartens ([7]). This domain encourages children to engage in playful and exploratory activities like *comparison*, *placement*, *visualization*, and *counting* ([7]).

A dish with salmon

Together with the kindergarten, we devised and executed a project focusing on **sustainability and statistics**. Two educators facilitated the activity involving 18 four-year-olds. Using the food the children ate for lunch in kindergarten, they created a bar chart with blocks to represent their food preferences.

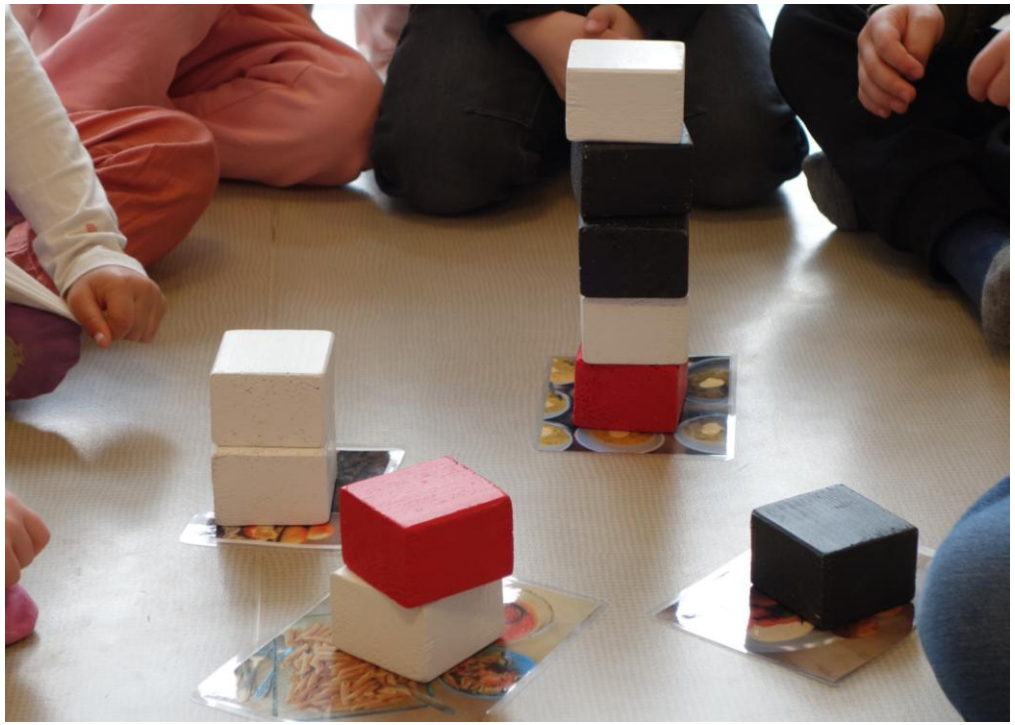
The subsequent **mathematical dialogue** helped them interpret the bar chart through comparison, numbers, and counting.

Collaboratively, the project was *tested*, *evaluated*, and *refined* to ensure the kindergarten's ownership and future implementation independence.



This study aims to address the research question:

How can the United Nations Sustainable Development Goal "Good Health and Well-being" be integrated as an approach to working with statistics in kindergartens?



Theoretical Framework

The Framework Plan for Kindergartens ([7]) guides children's activities in kindergarten, advocating a learning environment where **everyday experiences** and **surroundings** become foundations for learning. This approach situates reality as the backdrop for children's curiosity and exploration.

Consequently, multiple answers may emerge from each question, and inquiries can take many different directions to the question. Such a learning environment, fostering curiosity and enabling children to shape the learning journey, is termed an "**inquiry landscape**" by Alrø and Skovsmose (2002) ([11]).

Wells (1999) emphasizes that in an inquiry-driven **learning environment**, children ask questions, express wonder, and seek knowledge collaboratively ([4]). Throughout activities, spontaneous conversations may arise, but staff are tasked with guiding children back to the subject matter.

It is the staff responsibility to unite children around a shared academic theme, possibly using images or concrete materials ([14]). This **orchestration** provides context for activities and introduces mathematical concepts

Play is an important element in kindergarten. Björklund et al. (2018) propose four strategies that staff can use to facilitate play-based, targeted math teaching:

- *affirming interest*,
- *introducing new strategies*,
- *situating familiar concepts*, and
- *offering new perspectives* ([15]).

By **employing various strategies**, staff offer multiple avenues for children to tackle mathematical questions. Diverse strategies challenge the conceptual understanding of mathematical ideas in different ways, potentially broadening children's comprehension.

Physical objects used to support the development of children's mathematical skills, are known as **manipulatives**. Despite varying definitions, Sarama and Clements (2009) suggest manipulatives are typically regarded as *tangible objects children can touch and explore* ([16]).

Laski et al. (2015) identify four principles to effectively use manipulatives in math education:

(1) use the **same materials** over extended periods,

(2) begin with **simple manipulatives**, gradually introducing abstract forms,

(3) avoid objects resembling **everyday items**, and

(4) **clarify the link** between manipulatives and math content ([17]).

Implementing these principles may enhance teaching effectiveness, bolstering children's problem-solving and critical thinking, thereby improving math outcomes ([17]).

Jones et al. (2000) formulated a framework characterizing children's **statistical thinking** ([1]), drawing on Biggs and Collins' cognitive development model (1991) ([18]).

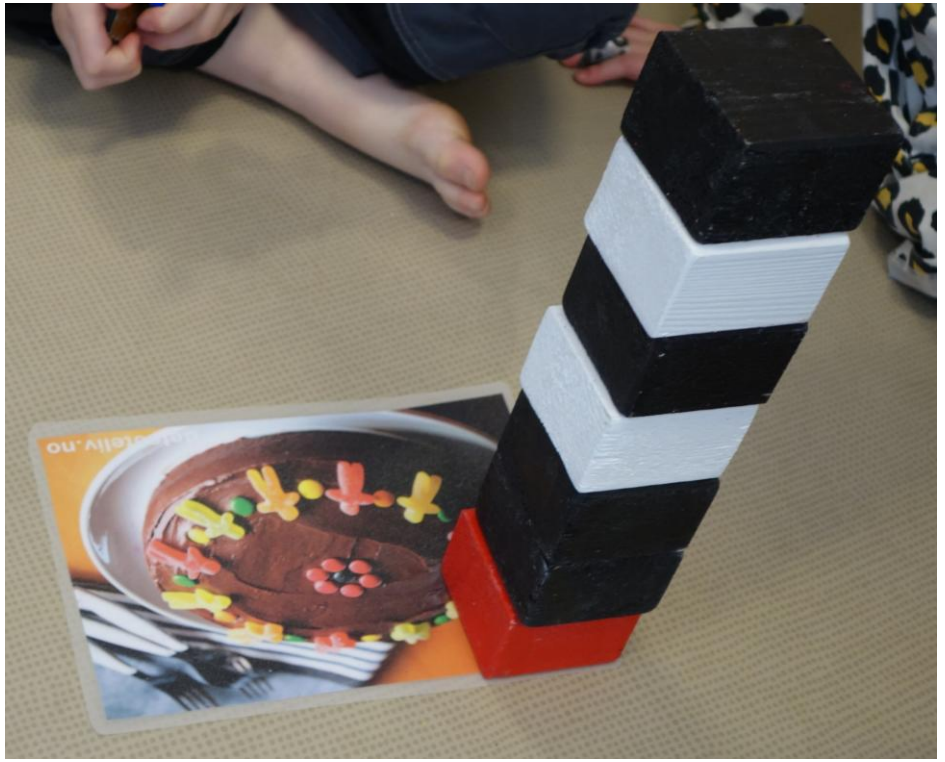
The framework consists of four categories:

(1) *describing data*,

(2) *organizing and reducing data*,

(3) *representing data*, and

(4) *analyzing and interpreting data*.



Metodology

This activity was conducted with **four-year-olds** participating in action research, consisting of **18 children** divided into **three smaller groups of six**. Kindergarten staff organized these groups.

The collaboratively designed project was executed at **different times** for each group, with adjustments made between sessions based on observations.

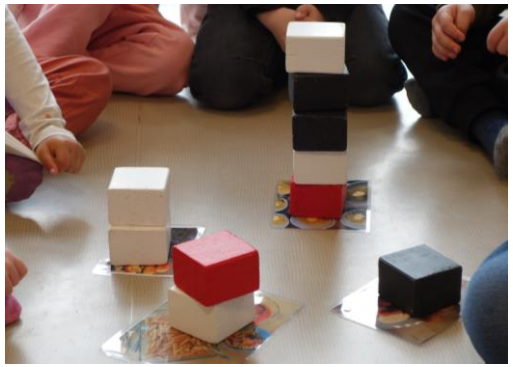
Notably, **the unhealthy category** received more attention, prompting a switch from chocolate cake to buns to remind children of the earlier conversation about healthy eating.

A change in staff leadership on the third occasion ensured greater staff engagement and experience with the project, aiding its future independent implementation.

The Activities With The Children (Design of the studie)

Collaborating with kindergarten staff, we devised a project where children engaged with themes of sustainable development and statistics. The activity **comprised two parts**.

1) The first part served as **an introduction**, immersing the children in discussions about healthy food.
2) In the second part, the children **constructed a bar chart** using blocks to visualize their preferred lunch choices. This activity was followed by a mathematical discussion. Observations from the second part form the data foundation for our study.

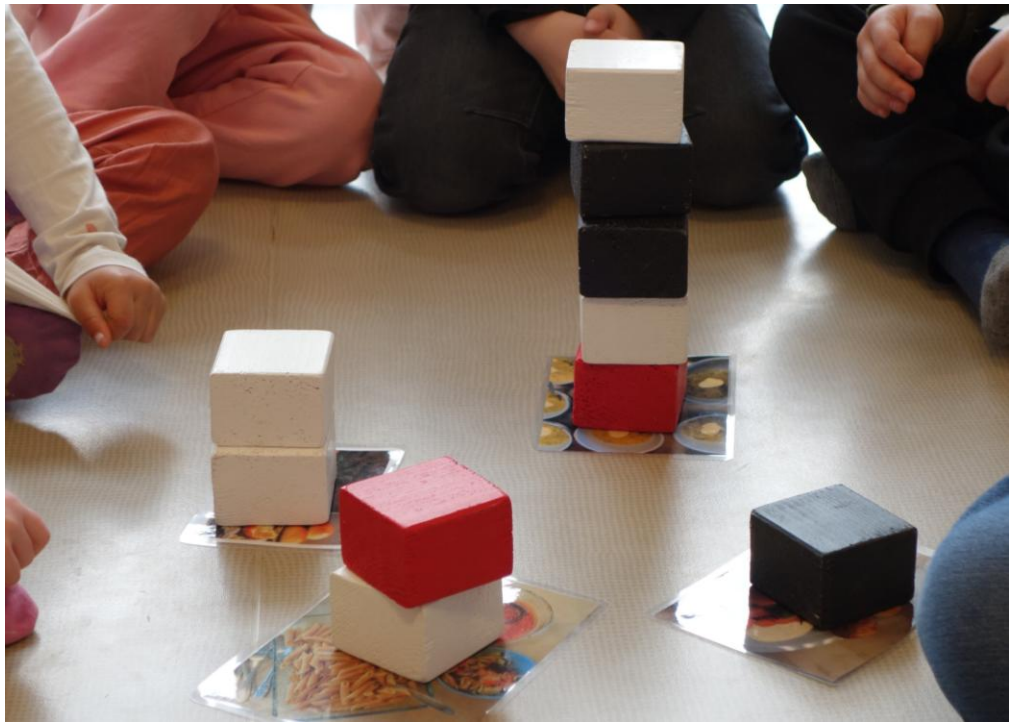


There were **four pictures** of four different dishes:

1. pasta with meat sauce,
2. salmon with potatoes,
3. spinach soup, and
4. one unhealthy option.

The spinach soup was cleverly called "Hulk's Soup," emphasizing growth and strength - capitalizing on the children's familiarity with the fictional character. The children made bar charts on the pictures of the dishes, based on which **dishes they liked**.

The blocks for **the bar charts** were in a variety of colors (red, white, and black), intended to enhance practice with mathematical concepts. After the children had discussed which dishes they liked best, they counted and discussed how many blocks of different colors there were on the different dishes and how many blocks in total.



Observation (Method)

Our observations aimed to **address the research question** and led to **adjustments during the study** (changing images and rotating staff members). While we observed the entire activity, observations from the second part, concerning lunch and the bar charts, most effectively answered the research question.

We prepared an **observation sheet** with two columns:

- one for observations, and
- another for reflections.

Each team member noted **observations independently**, documenting children's drawings, conversations, discussions about food, interactions over the stacked diagram, and collaborative efforts in creating it.

We also recorded **personal reflections** during this process. After individual reviews, we refined observations for the best data foundation to address the research question, repeating this process for all groups.

We synthesized observations **into six documents**, two per group, with each observation lasting about an hour, including 20 minutes focused on the bar charts activities. Overall, we compiled 18 pages of observations, with eight pages detailing the bar charts work.

Analysis

Our approach was **inductive**, initially identifying elements related to sustainability, and subsequently pinpointing data relevant to statistics and mathematics.

This analysis was guided by **a theme-based qualitative strategy** ([6]; [21]), which involves identifying **codes and categories** within observations to uncover patterns in the children's statements and actions (see Table 1).

Table 1 outlines **the analytical steps** that culminated in the identification of two main categories:

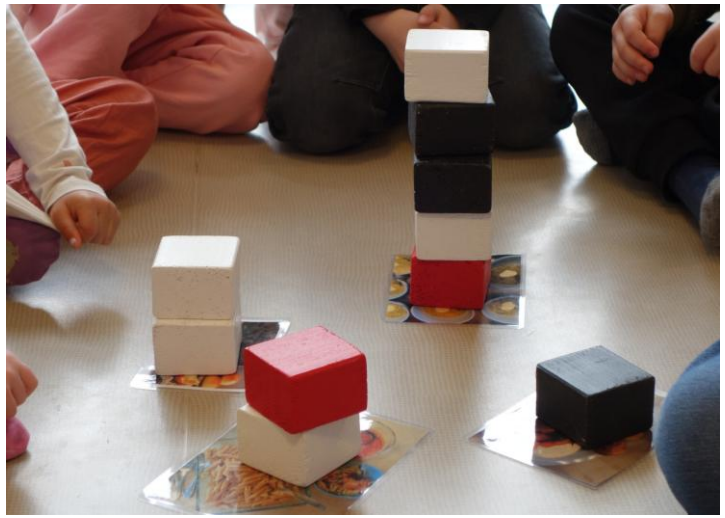
- numerical concepts, and
- statistical thinking.

Steps in the analysis strategy	
Faamiliarize with the data	We summarized observations from each of our observations and transcribed the data material.
Define the scope of the data	Observations and statements related to healthy food and sustainability, examples of statements from children related to the categories in the stacked diagram: "I like salmon," "Fish makes you big and strong," "Then we get big muscles, bigger than the Hulk."
Create initial codes	After identifying healthy food and sustainability, we found codes related to mathematics and statistics for further analysis. Examples of codes: highest, lowest, 1, 2, ..., 10, red, white, black, 7-1-2-2, 4-2-3-3.
Search for categories	After organizing the codes, we identified overarching categories for the codes: Number Counting Relational word (highest/lowest, most/fewest) Sorting/quantities
Define the categories	In this step, we merged the categories into the two main categories: numerical concepts and statistical thinking.

Tabel 1. Steps in the analysis strategy

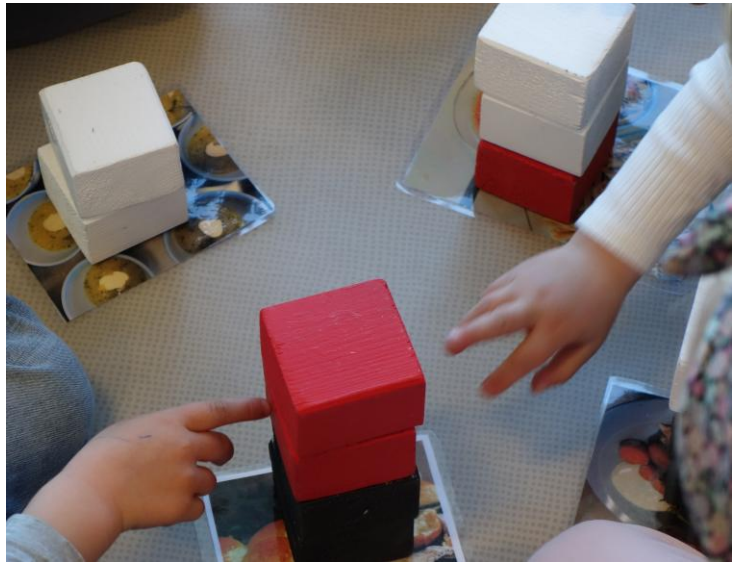
Results and Discussion

When the children counted and provided numbers, they articulated these using number words; for simplicity, we have represented these as **numerical symbols**.



When the children counted the blocks in a tower in the bar chart, reaching 1-2-3, or when they tallied all the blocks as 1-2-3-…-11-12, we classified this as **counting**.

The concept of number was evident when the children pointed at a tower and said 'two' or when they counted the blocks in a tower and repeated the last number, 1-2-3-4, 'four'. Their ability to count up to twelve demonstrated knowledge of **number sequences** and mastery of **one-to-one correspondence**, linking a number word to each block counted.



Saying '*two*' without counting blocks exemplifies immediate number perception. Understanding of **cardinal numbers** was shown when children reiterated the final number in their count as the quantity of items in the set.

In Table 2, observation codes are organized under two main categories with corresponding subcategories. The numbers within the sorting/quantities category reflect expressions from the children and the adult summarizing the block counts across various dishes.

Main Categories, Subcategories, and Codes in the analysis			
Numerical Concepts		**Statistical Thinking**	
Number	**Counting**	**Relational word**	**Sorting/quantities**
4 7 3	1,2,3,4....,12 1,2,3,4	highest lowest fewer most equal amount	7-1-2-2 4-2-3-3 Salmon

Table 2. Main Categories, Subcategories, and Codes

Our observations indicated that the staff member utilized the third approach described by Björklund et al. (2018):

- embedding mathematical content in a playful context ([15]).

Children are accustomed to **building towers during play**, and this context was adapted to tower construction representing quantities of different dishes.

Familiar play elements were thus integrated into a mathematical context to engage with statistical concepts via **block-based stacked diagrams**.

For effective **inquiry-based learning**, it is crucial for the staff member to direct activities purposefully ([13]). The staff member's role is to bring children together around a shared scholarly subject ([14]).

Using dish images and physical wooden blocks (bar chart), the staff member steered discussions towards **numbers** and **numerical relationships** (fewest/most). This created a learning environment where children's questions and curiosity fostered an **inquiry landscape** ([11]).

Working with *the bar charts*, the children engaged with both **statistical elements** and **numerical concepts** in mathematics.

Counting and verbalizing number words are fundamental to **numerical concepts** in mathematics. By physically creating the bar charts, the children explored statistical thinking, particularly within two categories in the framework by Jones et al. (2000) ([1]).

They **represented data** by crafting the bar charts based on favored dishes. Observing the bar charts and counting blocks allowed them to interpret data, discerning which dish was more or less popular (most or fewest liked).

Taking **a broader perspective** - a mathematical one - reveals that the children explored *the mode* (the most "typical" observation, represented by the dish with the most blocks).

This **measure of central tendency** is one they will encounter later in school statistics. It is the sole measure applicable here since diagram categories are non-numerical data. Relating this activity to measures of dispersion isn't feasible, as definitions of measures of dispersion rely on numerical data.

Conclusions

The mathematical focus of our study is on **statistics**, yet interpreting a statistical representation requires contextual placement. In our research, this context was built around **sustainability** and **healthy food**.

The study begins with the research question:

> "*How can the UN's Sustainable Development Goal of Good Health and Well-being be utilized as a framework for teaching statistics in kindergarten?*"

We addressed this question by illustrating a project suited for kindergarten settings.

Considering the age of the participants, *four-year-olds*, we employed **orchestration** ([5]) to establish a foundational framework for linguistic interactions.

By having the staff member initiate the session with a reading from a book about baking, we aimed to convey the message that excessive *consumption of cake and candy* is **undesirable**.

Instead, children should focus on consuming **healthy foods** daily, recognizing their role in promoting overall health and well-being ([3]). Incorporating familiar dishes within the context of healthy eating proved to be an effective educational tool for engaging the children.

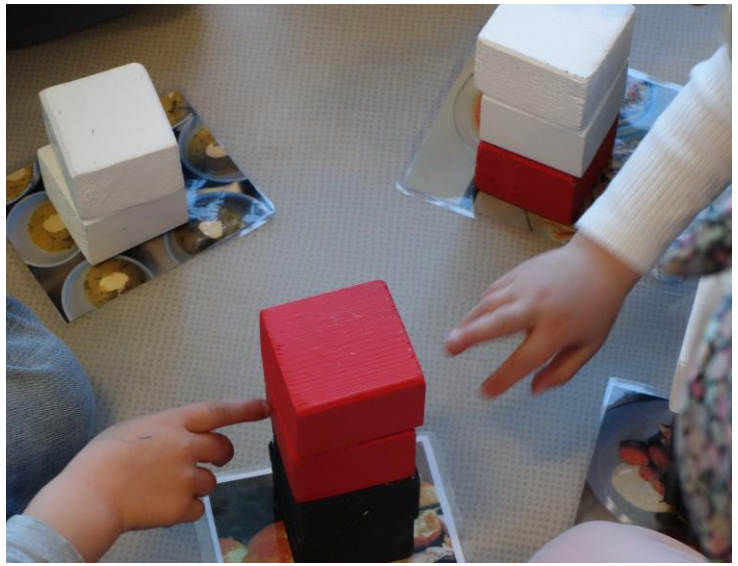
The study's project was crafted by designing **a learning environment** reflective of the children's everyday experiences and surroundings.

This method created a natural setting where children could explore and engage actively in the learning process. By focusing the study on lunches eaten at kindergarten, we crafted a playful yet meaningful mathematics project that integrated mathematics within the context of Good Health and Well-being

The interactions between children and staff were notably characterized by **curiosity** and **communication**.

Often, staff members guided discussions to ensure children received answers to questions related to the study's **academic theme**. The staff **orchestrated** both conversations and activities, highlighting the importance of their role.

When the project was conducted by a different staff member, it noticeably influenced **the quality of orchestration**.



For **future exploration**, it would be compelling to examine how this implementation might vary with another group of four-year-olds if the staff member had read a book focused on *healthy food* instead of baking.

Additionally, it would be interesting to assess the impact of using *uniformly colored blocks* to determine whether the color aspect holds any significance.

Thank you!

Question?

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