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Lunch in Balance: Designing for Healthy Eating Behaviour and Teacher Support in Dutch Primary Schools

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Abstract

The implementation of communal lunches in schools plays a crucial role in shaping children's eating behaviours and promoting healthier lifestyles. This research aims to investigate how the organisation of the communal lunch in Dutch primary schools with a continuous schedule can be improved to promote healthy eating behaviours among children while also fostering a more feasible and pleasant experience for teachers. The key needs and opportunities for intervention are identified using teacher surveys, expert interviews, literature research, and analysing existing work. A layered design framework was developed to guide the ideation and creation of an intervention. Based on this, an intervention was designed that includes an interactive device with physical character figures that, when placed on the device, trigger an audio-based storytelling experience guiding children through lunch with healthy eating behaviour cues and activities. A complementary web application displayed on the Digibord can provide visual support for children and assists teachers with supervision. The preliminary evaluation findings indicated that the concept shows the potential to improve lunch break in primary schools. However, further development and future research is needed to assess long-term integration in the classroom and its effects on healthy eating behaviour.

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Contents

Chapter 1

Introduction

1.1 Problem statement

Obesity is an increasing problem [1]. Childhood eating behaviours indicate future overweight and risk of obesity [2]. It is crucial to develop healthy eating behaviours to decrease the risk of chronic health conditions and to assist children in maintaining good health [3]. Childhood is a critical period in the development of obesity, as mentioned by Scaglioni et al. [2]. This aligns with the view of Birch and Ventura [4] who highlighted that the best opportunity to prevent childhood obesity is early prevention. Therefore, it is important to teach healthy eating behaviours to children in an environment that models these practices [5] and reaches children of all risk groups equally, so that all children can benefit without stigmatization effects [6]. The school environment is particularly well-suited for this purpose.

In the Netherlands, each primary school can determine their own daily schedules, as long as the legally required teaching hours are fulfilled [7]. However, there are some standard school time models, a lot of primary schools implement. In the past, most primary schools applied the traditional school hours model. According to DUO, in 2011-2012 77% of the Dutch primary schools followed traditional school hours [8]. With this traditional school hours model, there is a relatively large lunch break where children either have lunch at home or in the school's supervised lunch program. Nevertheless, over the last years, more and more primary schools have shifted from such a traditional school hours model to a continuous schedule. In 2019-2020 half of the primary schools adopted a continuous schedule (or a variation thereof), in which the lunch break is relatively short and it is mandatory for every child to eat their lunch at school with the supervision of the teacher [8].

According to Fossgard et al. [9], the most favourable lunch experiences for children occur in a calm environment without disruptions. Often teachers implement a communal activity to maintain this calm environment. Besides outdoor play and reading aloud, watching television during lunch is the most frequently implemented activity [10]. This because it facilitates a more orderly eating environment within the assigned time [11]. Although the specific impact of watching a television program during the school lunch has not been extensively studied, existing research provides insights into the effects of television watching in experimental and domestic settings. It is demonstrated that children unfamiliar to eating while watching television are more likely to become distracted and eat insufficiently [12]. But once children develop the habit of eating while watching television, they tend to overeat when given the opportunity [13].

1.2 Research question

It can thus be concluded that it is essential for the health and development of students that the lunch break is used responsibly and remains manageable for teachers. Therefore, the objective of this research is to explore how the lunch break in schools can be improved for both children and teachers. From this, the following research question is formulated:

"How can the organisation of the communal lunch in Dutch primary schools with a continuous schedule be improved to promote healthy eating behaviours among children while also fostering a more feasible and pleasant experience for teachers?"

In order to address this primary research question, the following sub-questions have been formulated:

1. What factors influence the implementation of lunch at schools with a continuous schedule?
2. What opportunities exist to improve its implementation and promote healthy eating behaviours?
3. What insights from related work and comparable interventions can inform the design and implementation of the current concept?
4. Which design objectives and requirements can be identified and how do these guide the development of the concept?
5. To what extent does the concept demonstrate its potential to meet the identified objectives and requirements?

1.3 Report outline

This report is designed to provide an overview of the research's key components to systematically address its goal. The second chapter explores the background context of the lunch break practices in Dutch primary schools that have implemented a continuous schedule. Chapter three focuses on the user context with teacher interviews. Chapter four dives into the related work related to the context in this domain and others. Translating all the research of the context into a design approach, is described in Chapter five. Building on this, Chapter six outlines the ideation phase. In Chapter seven, the chosen concept is elaborated. A prototype based on this concept was created and is explained in Chapter 8. To test the potential of the concept, a couple of initial evaluation tests are performed and discussed in Chapter 9. Finally, Chapter ten and eleven present the discussion and conclusion of this study, respectively.

Chapter 2

Background

A comprehensive exploration of the current situation, its consequences, the characteristics of healthy eating behaviour, and the identification of a focus area and target group will be described in this chapter. These explorations were primarily conducted in the Research Topics report preceding this thesis [14]. This section aims to summarise the essential background knowledge necessary to understand the findings presented in this thesis, while also providing contextual narrowing of the research scope. For this section, multiple methods were used, such as literature, a conducted survey and expert interviews.

2.1 Current practices

This section examines the current practices regarding lunch breaks in Dutch primary schools. This provides insights for understanding how lunch breaks are currently structured and shaped.

2.1.1 Continuous schedule

As stated in the introduction, more and more primary schools have shifted to a continuous schedule. According to DUO, half of the primary schools implemented a continuous schedule (or a form of it) in 2019-2020 [8], which is expected to be significantly higher now in 2025 compared to 5 years ago. A key aspect of a continuous schedule is the requirement for all children to remain at school during a shortened lunch break [8]. With a continuous schedule, the lunch break is fully integrated into the school day [15]. The school is responsible for the children and the teaching staff takes care of the children themselves [16]. Most of the time, the children have a quick meal after which they are often allowed to play (outside) [17]. The 5-equal-days model, as described by Witteman-van Leenen and de Weerd [18], closely resembles the continuous schedule but differs in five school days with uniform start and end times instead of one or two afternoons off. Therefore, this model is classified as a continuous schedule.

2.1.2 Current organisation of the lunch

In order to investigate what the current organization of the lunch break at schools entails, a survey among Dutch primary school teachers (n=58) was conducted as part of the research topics [14]. The results of the survey offer valuable insight into current lunch break practices and highlight areas that need improvement. Key findings reveal important trends and challenges. The survey revealed that the largest group of respondents has a total break duration of 30 minutes, of which 15 minutes are allocated to eating lunch, which is quite

little time to eat. These findings align with the impression food expert Floor Scheffers highlighted in her interview. Only half of the respondents stated having personal time during the break.

Almost all participants implement activities during eating, where watching TV and reading aloud are the most reported. A study in 2023 by NOS Jeugdjournaal [10], conducted among 1000 primary schools in the Netherlands, also examined these activities during the communal lunch. Their research showed similar results, where watching a television program while eating lunch was the most commonly used strategy [10]. Reasoning for incorporating activities mentioned in the survey is to maintain a calm atmosphere in the classroom and to align with school policies that assign the lunch break as part of educational time (which is the case for the majority of the respondents). According to the Dutch government [19], primary school students are required to receive at least 7,520 hours of education across eight years of primary education. With the exception of a few general regulations, schools have complete autonomy in how they allocate and structure this time, allowing the lunch break to be included as part of educational hours.

In addition, the vast majority of teachers reported implementing certain rules during the lunch period, with the requirement to remain quiet being the most frequently mentioned. Teachers' experiences of the lunch period varied widely, ranging from very positive to quite negative, highlighting the need to consider these differing perspectives. Furthermore, many respondents acknowledged not focusing actively on teaching healthy eating behaviours (which will be explained in Section 2.3) to their students. Notably, half of this group expressed no willingness to incorporate such practices into their teaching. Reasoning behind no willingness of half of the respondents was not addressed in the survey. But it can be hypothesised that the thought of additional tasks or workload arises quickly when teachers are asked if they would be open to incorporating a focus on healthy eating behaviours as part of the lunch break. However, this perception does not necessarily have to reflect the reality.

2.2 Consequences

Now that current practices have been established, their consequences and impacts will be identified. Understanding these consequences is crucial, as they directly influence children's eating behaviours.

2.2.1 Overeating

The influence of watching television during school lunch has not been studied, as far as could be determined. However, research has been conducted on the effects of watching television (or other cognitive demanding activities) during meals within an experimental or domestic setting. From this research it became clear that overeating can occur when watching television while eating [13]. Engaging in a task, such as watching television, that diverts attention from food can lead to "mindless eating" [20, 21]. Mindless eating refers to the concept that unconscious decisions about food can significantly impact our diet and weight (in contrast to mindful eating) [5, 22]. In addition, Vik et al. [23] found that children who reported never watching television during lunch and dinner had lower odds of being overweight compared to those who did. This suggests a potential link between watching television during meals and weight status.

A closer examination of the literature on this consequence of overeating reveals that this is likely driven by several potential factors. One of the factors is the eating behaviour in front of the TV, which includes the sedentary nature of the activity [20, 23] and the allocation of attention resulting in mindless eating [21]. Mindless eating may damage self-monitoring [13], influence habituation to food cues [24], and result in less vivid memories of the meal itself [25], all resulting in higher intake. Furthermore, there are also indirect factors such as the influence of (discreet) TV advertising of food and beverages [23] and the role of TV in shaping personal beliefs and social norms about things like appropriate eating behaviour and physical appearance [20]. Lastly, the content of the video itself can be a factor, as food intake may be influenced by experiencing negative or positive emotions [21] and in response to negative emotions people may tend to overeat (emotional eating) [26].

2.2.2 Insufficient food intake

However, it is not only overeating that can occur. Those implemented activities can also reduce the intake among children [12]. This is likely explainable by the findings reported by Ogden et al. [27]. They highlighted that distraction 'should be understood as a multi dimensional model which influences the attention available not only for both perceiving the desire to eat but also engaging in the process of eating' [27]. Food intake itself requires some cognitive effort to focus on external or internal stimuli [28]. Examples of these stimuli are the amount consumed [29], the characteristics of the food [30], hunger or fullness feelings [27], and eating goals [31], which all require attention. If a child is too distracted from eating, the child will have insufficient cognitive capacity left to participate in their eating behaviour [27]. This can be traced back to whether a (young) child has experience with eating while watching television, as was outlined by Francis and Birch [12]. In addition, Chapman et al. [32] found that the more engaged the participants were in watching television, the less they ate.

2.2.3 Relevance to the school context

It can be argued that overeating is restricted in school lunches due to the fact that there is a limited amount of food in the lunch box of the students. Nevertheless, through compensation for earlier restrictions later in the day, children may still overeat, potentially due to having less vivid memories of their meal. In addition, it is crucial to teach healthy eating behaviours to children in an environment that models these practices for all students. Among others, childhood eating behaviours indicate future overweight and obesity, as stated by Bozkurt et al. [5]. In line with this, Scaglioni et al. [2] identified childhood as a critical period in the development of obesity. Early prevention is therefore of high importance [23].

2.3 Healthy eating behaviour

A healthy eating behaviour is important for the development and long-term well-being of children. From interviews with nutrition experts as part of the Research Topics [14], it became clear that a healthy eating behaviour in the classroom is shaped by multiple aspects, including access to nutritious food options, mindful eating practices, sufficient time to eat, and behaviours that are non-eating related (such as commensality), as visualised in Figure 2.1 below.

FIGURE 2.1: Overview of healthy eating behaviour aspects

2.3.1 Healthy diet

As defined by Haines et al. [33], a healthy diet occurs when the usual eating patterns of someone include adequate nutrients and a well-balanced intake. A sufficient but not excessive energy intake is important for the individual as well to meet their energy needs [33]. The concept of *healthy diet* is fundamental to supporting both the physical health (such as body weight and immune function) and cognitive development of children. To ensure an adequate intake of these essential nutrients, it is important to eat a variety of foods, as each food offers a unique mixture of nutrients [34]. According to the Dutch 'Gezondheidsraad' [35] and 'Schijf van vijf van het voedingscentrum' [36] their are 5 main categories of healthy food. It is advised to eat vegetables and fruits, whole grains or minimally processed whole-grain foods, healthy protein sources (such as beans, nuts, fish, eggs, and dairy products) [37]. In addition, soft margarine, liquid oils, or vegetable oils should be used for cooking. Lastly, water should be the primary drink of choice with every meal and snack, as well as during physical activity.

Food preferences vary between individuals. They are influenced by the foods offered and are a key determinant of food intake among children [2]. Through role modelling, providing access to nutritious foods, and encouraging healthy eating habits, families contribute significantly to the establishment and maintenance of beneficial dietary practices [2, 38]. Moreover, the socioeconomic status (SES) of parents significantly influences children's dietary intake. A strong association between lower socioeconomic status and higher rates of obesity has been shown by research, particularly in developed countries, as individuals with lower incomes are often more likely to consume unhealthy foods due to cost considerations [39].

In Dutch primary schools children typically bring a pre-packed lunch box. Parents or guardians are thus responsible for packing their children's lunch boxes. Therefore, they play a key role in determining what children eat during lunchtime at school. This responsibility often includes making decisions about the nutritional value of the food. However, many schools have already implemented guidelines with regard to the contents of lunch boxes. For example, it is common for schools to prohibit items such as cookies or sweets or allow only water as a drink. However, the application and extent of these rules differ between schools.

2.3.2 Mindful eating

Encouraging positive eating habits goes beyond what is eaten and includes how meals are consumed as well. The way children engage with their food can have a significant impact on their nutritional intake and overall eating experience. One key aspect of improving positive eating habits is promoting mindfulness during meals. Mindfulness is a state of consciousness, defined as "the awareness that emerges through paying attention on purpose in the present moment, and non-judgmentally to the unfolding of experience moment to moment" [40, p. 145]. Mindful eating is an approach that applies mindfulness strategies to eating practices [41], and can be defined as "a non-judgmental awareness of physical and emotional sensations while eating in a food-environment" [42]. Mindful eating techniques encourage paying attention to body related sensations as well as feelings and thoughts about food, in a way that is free of judgment [43].

By promoting this awareness, intuitive eating will be stimulated that prioritises internal physiological factors, rather than externally driven (emotional) factors, promoting healthier eating behaviour [44]. This includes full awareness of food consumption by paying attention to body cues and signals incorporating the practice of eating slowly. Insights from both interviews with experts and literature [41] underscore the importance of these techniques to encourage a more balanced approach to meals. Mindful eating interventions are increasingly being used to promote healthy eating habits [44, 45]. Some clinical studies found that mindful eating interventions can have positive effects on promoting balanced and variety eating and reduce obesity in school-age children and adolescents [46].

Mindful eating consists of several key aspects, which can be divided into physical and emotional sensations. The physical sensations involve aspects like physical cures and chewing. The emotional sensations can be subdivided into three dimensions: sensory, psychosocial, and interpersonal dimensions. An overview of the elements can be found in Figure 2.2 below. These elements will be explained in the following sections.

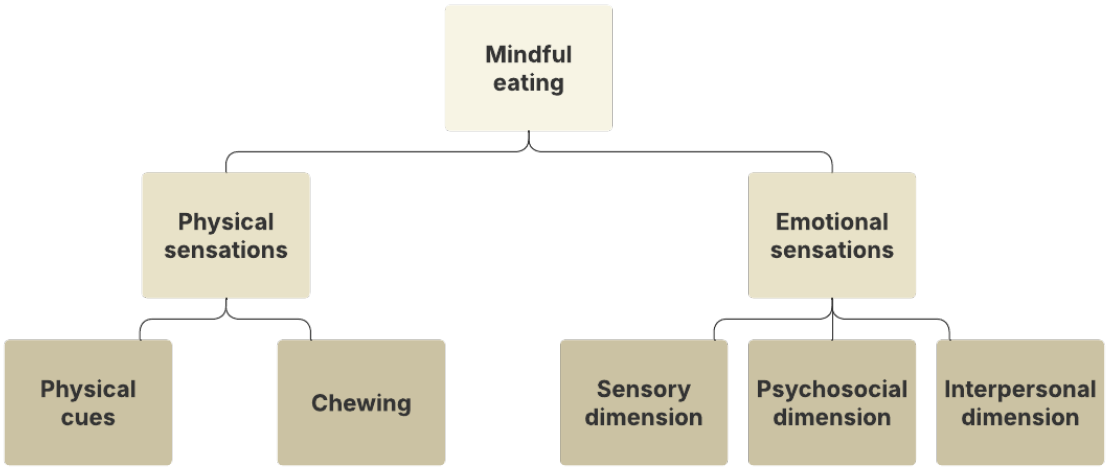

FIGURE 2.2: Overview of the mindful eating aspect

Physical sensations

Physical sensations play an important role in shaping eating behaviour and fostering a mindful approach to meals. A crucial aspect of mindful eating involves developing awareness of the physical cues to eat, which can enhance self-regulation [44]. Kristeller and Wolever [47] emphasise the importance of becoming aware of sensations related to physical hunger and satiety, including both stomach fullness and sensory-specific satiety. Practising mindful eating has been shown to create positive changes in recognising fullness and increase awareness of physiological experiences, as demonstrated by Chiba and Yoshiike [41]. Children naturally have the ability to internally respond to hunger and fullness cues from birth [42] [48]. Some evidence, however, indicated that these self-regulatory abilities diminish as children get older [49, 4], which can partly be attributed to parenting practices that encourage children to focus on external cues rather than their internal hunger and satiety signals [4].

Insight from expert interviews highlighted that, in addition to paying attention to your physical cues, proper chewing behaviour an important component of mindful eating is as well. This because it is the start of food digestion. Children who ate fast were observed to have a greater number of bites per meal, fewer chews per gram of food, larger average bite sizes, and a shorter oral exposure time per bite [50, 51]. Fogel et al. [50] further mentioned that, as a result, these children with a fast eating rate consumed more energy during their meal and are associated with an increased body weight [50, 51, 50]

In contrast, slow eating has been associated with lower energy intake and a reduced risk of obesity [52]. One possible explanation for this is that the brain recognises satiety signals only after a certain amount of food has already been consumed, which can lead to overeating in fast eaters [52]. Chewing properly has been suggested as a potential strategy to reduce one's eating rate, as concluded by Okubo et al. [52]. However, it is crucial to consider not only the risk of being overweight as a consequence of eating rate and chewing behaviour, but also the risk of thinness. Although little is known about the relationship to the risk of thinness, Okubo et al. [52] showed that slow eaters had a significantly higher prevalence of thinness. However, no clear association was identified between the degree of chewing and thinness [52].

Research highlights significant differences between boys and girls regarding chewing behaviour and specifically eating pace. As mentioned by Okubo et al. (who conducted a study among children aged 5-6 years) [52], boys are more likely to eat faster than girls. This finding is further supported by Fogel et al. [50] who noted that boys have a faster eating rate than girls, and this gender difference grows with age. They attributed this difference to boys taking larger bites, having shorter oral exposure times, and chewing less thoroughly compared to girls [50]. These physiological and behavioural factors underline how gender influences eating habits.

Emotional sensations

Food consumption and pleasure are closely intertwined, since the necessity of eating is shaped by a secondary dimension of enjoyment [53]. According to Reitmeier [53], emotional factors and emotional bonds formed around consumption of food play a crucial role whether eating is perceived as an enjoyable, indifferent, or even unpleasant experience. The pleasure derived from eating is therefore fundamental in guiding food choices, as em-

phasised by Hainesa et al. [33]. When children do not have a pleasurable and satisfactory experience with food consumption, it can diminish their enjoyment of eating and drinking in the future [53]. In addition, pleasure can also be a risk for healthy eating, particularly in terms of food selection and calorie intake, especially in today's environment filled with energy-dense foods.

To encourage healthy eating habits among children, it is essential to understand how and when pleasure is derived from food consumption [54]. Marty et al. [54] have outlined three key dimensions of pleasure from eating: 1) the sensory dimension, 2) the psychosocial dimension, and 3) the interpersonal dimension. The sensory dimension relates to the pleasure experienced during and after eating, influenced by the perceptual characteristics of food (such as taste, appearance, texture, and flavour). Differences between individuals in taste perception can arise from genetic variations in taste receptor genes, contributing to unique dietary patterns among individuals [55]. The psychosocial domain involves the pleasure of eating associated to cognitive processes of eating, such as thoughts, ideas and images connected to food. Finally, the interpersonal domain encompasses the pleasure experienced from the social context of food consumption, since eating is often a social matter. As noted by Shutts et al. [56], social eating fosters interactions between people during a meal and can significantly influence the development of eating habits. Discussing the food being consumed, for example, is a powerful element of social eating [33]. More details on social eating are discussed in Section 2.3.4.

2.3.3 Lunch timespan

It is essential that children have enough time to eat their lunch [3], as inadequate time can have disadvantageous effects on their nutritional intake [57, 58]. If lunch breaks are too short, they can lead to reduced consumption of important nutrients [3]. Bergman et al. [59] observed that when there is too little time, children will prioritise foods they find more appealing, which are typically not the fruits and the vegetables. In addition, shorter breaks may result in children eating too quickly [57], which can diminish their ability to self-regulate their food intake and appetite [58]. Clarke et al. [57] also noted that in schools where children were allowed to play outside after finishing their lunch, stakeholders expressed concern that children were eating less to make sure they have more time to play outside.

The duration of a lunch break is therefore a crucial factor in ensuring that children have adequate time to eat their lunch. Literature generally recommends at least 20 minutes of time to eat, also called 'seat time' [58, 59, 60, 61]. It is important to distinguish between this effective seat time and the total lunch break duration, as some activities like using the restroom, washing your hands, and retrieving lunch items can shorten time available to eat [61]. Bergman et al. [62] highlighted that out of the 20 minutes of effective seat time, children spent between 9 and 16 minutes actually consuming food, depending on whether the child is a slower eater and therefore needs more time. Additionally, 5 to 10 minutes were typically spent on socialising, however, an optimum amount of social time during lunch is yet unknown [62].

Lastly, it was found that the adequate time to eat varies by age, as younger children generally take longer to eat than older children [57]. For instance, a study found that kindergartens (5-6 year olds) took an average of 2 minutes 42 seconds longer to consume their meals compared to fifth graders (10-11 year olds) [59]. Younger children also tend to

spend more time on non-consumption activities, such as socialising, organising the eating area, and playing with food, which can further extend meal duration [59].

2.3.4 Non-eating behaviours

As briefly mentioned in the previous section, non-eating activities during school lunch play a crucial role in children's overall development as well. Activities like arranging the eating area, playing with food, and, most importantly, socialising are important non-eating behaviours [59]. Berggren et al. [63] emphasised that social interactions and friendships are central to the lunchtime experiences of children. In line with these findings, Fossgard et al. [9] observed that children greatly valued companionship during lunch, with the presence of friends being particularly important among children. To support this perspective, Spence et al. [64] highlighted that eating together a hugely essential social activity is, offering a valuable opportunity for children to practice and develop important social skills.

One could argue that after the eating part of the lunch break, children often go outside to play, which could also be a moment to socialise instead of during the eating part. However, as Baines and MacIntyre mentioned, "while mealtimes may share features with the playground context, they may also afford distinct opportunities for socialising with peers" [65, p 167]. Reason for this is that mealtimes may bring children into contact with peers they will not meet on the playground and create an environment that is more likely to promote talk-based interaction than active play where children can find out about each other [65].

Conversation is a significant aspect of social interaction with others, including activities like chatting, telling jokes, and sharing riddles [63]. Additionally, Fossgard et al. [9] observed how food items in the lunch box of children served multiple social purposes. For example, sharing food, such as a couple of grapes or strawberries, is "a way to express emotions and feelings of sympathy and friendship, or gain attention, be liked and socially accepted by the other classmates" [9, p. 145].

Commensality (the practice of eating together and engaging in positive social interactions) has been linked to beneficial meal experiences [64]. Eating with others (as opposed to eating alone) can foster a positive mood and create a sense of enjoyment [64], which discussed in Section 2.3.2 plays a crucial role in food consumption. Similarly, Berggren et al. [63] found that children associated social interactions with having a pleasant lunchtime. However, it was noted that social interaction with others could pose challenges, potentially leading to negative emotions such as fear of loneliness [63]. These negative experiences often arise from undesirable behaviour, such as unrest, disturbances, haste, or when strict rules require children to sit at their desks silently, as reported by Fossgard et al. [9]. Children expressed a desire for freedom and not oversteering, but also acknowledged the need for appropriate supervision to prevent noise and disturbances [9].

2.4 Design challenge

A clear understanding of the current situation, its impact on eating behaviour, and what constitutes healthy eating behaviour is gained. Understanding how schools can create an environment that not only supports effective lunch implementation for the teachers, but also encourages healthy eating habits among students is crucial, given the growing concern

about children's nutrition and well-being [5].

It can be concluded that school lunch practices are shaped by a variety of factors. Approaches to lunchtime vary among different primary schools. But also within the same school, lunchtime practices can differ between classes. Even within the same classroom, students' lunchtime experiences can vary significantly due to individual circumstances and preferences. Accordingly, the identified factors in this study operate at different levels, which are school level, classroom level, and individual level factors. All these different factors and their associated levels are illustrated in Figure 2.3 below to provide an overview of the factors that emerged during this research. This overview aims at providing the clearest possible understanding of these influences and factors contributing valuable insights into the complexities surrounding the dynamic school lunch practices.

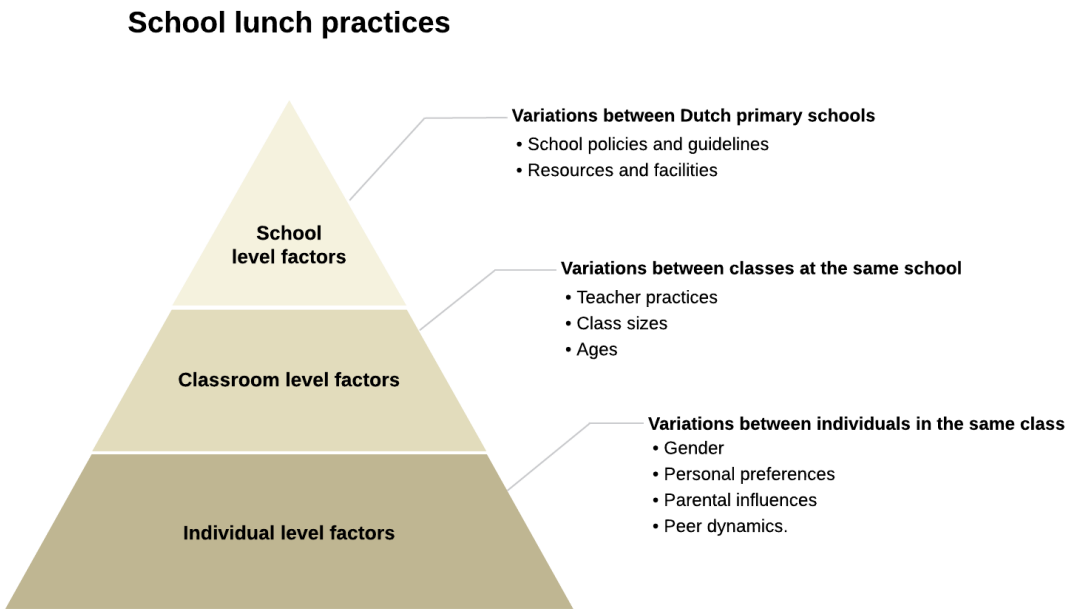

FIGURE 2.3: School lunch factors and their associated levels

2.4.1 Challenge opportunity

Given the variety of factors at different levels, there are different opportunities to improve lunch break in Dutch primary schools that implement a continuous schedule, while also promoting healthy eating behaviours across various aspects for children. However, these multiple factors make the lunch break a highly complex challenge, as it is difficult to address every factor (simultaneously) and satisfy the needs of all individuals involved. The following can be concluded when examining these factors from a practical perspective. When considering school-level factors, such as school policies and available resources, these are beyond our reach to influence, as they fall under management-level decisions that are outside our direct control. Analysing the individual factors reveals that, while they influence lunch break experience and eating behaviour of children, there is limited scope for direct intervention.

Evaluating the classroom level factors reveals that while class size and age are quite fixed and unchangeable, teacher practices present a promising opportunity for improvement. The way teachers organize and implement activities during lunch break significantly influences children's eating behaviour. It can thus be concluded that teacher practices, while keeping the other factors in mind, is the most promising way to enhance the lunch break and promote healthier eating behaviours, considering both practical feasibility and the diverse needs of children and teachers.

2.5 Target group

The Dutch primary school covers a wide age range from 4 to 12 year old children with significant developmental differences. Therefore, the target group was narrowed down to focus specifically on young children (aged 4 to 8 years; the lower grades of primary school). This choice is based on two main reasons. First, this is a crucial developmental phase. At this age, many innate reflexes are still present but tend to fade as the child matures. These reflexes represent simple, automatic bodily responses to stimuli, a form of innate and natural will [66]. Second, findings from the survey indicated that teachers of the lower grades face the greatest challenges and responsibilities during lunch break, often because young children are generally less independent at that age.

Several key characteristics of young children were found that should be taken into account when designing for them. Firstly, young children have a strong preference for habits and routines [67]. Secondly, young children gather a large amount of knowledge about the world around them, and their understanding of functional relationships grows rapidly [67]. Lastly, important cognitive skills such as number sense, time awareness, and literacy develop primarily in the latter half of this age group [68]. These aspects are crucial to consider when designing educational or behavioural interventions for young children.

Education for young children can contribute significantly to optimise their developmental potential, provided that we take into account the ways in which they learn and grow [67]. Young children develop best when they have ample opportunities to gain concrete experiences [67, 69]. From a behaviourist perspective, learning is viewed as a lasting change in behaviour resulting from acquired experience [70]. In addition, optimal development occurs when they are actively engaged, perceive the activity as meaningful, have sufficient time to play within their activity schedule, and when developmental domains are addressed in an integrated manner [67]. To promote active participation, engagement and motivation for learning, an intervention should align with the world of experience of children [71].

Chapter 3

User context

Teacher practices, while keeping the other factors into account, appear to be the most promising approach to improve lunch break, and promote healthier eating behaviours. With this approach both practical feasibility and the diverse needs of students and staff need to be considered. Therefore, this chapter provides a more detailed examination of the tasks teachers have to carry out to ensure a smooth lunch break, challenges teachers encounter, and what needs to be taken into account for the target group.

3.1 Method

In order to achieve this, four interviews were performed with Dutch primary school teachers. These interviews were semi-structured. The prepared interview questions can be found in Appendix D. The four teachers that were interviewed are all from different primary schools. Teachers who participated in the interviews all teach children in grade 1-4 (target group). The interviews were conducted online and lasted about 30 minutes. The interviews have been approved by the Ethics Committee of Computer and Information Science of the University of Twente. The information letter and the consent form as part of the ethical procedure can be found in Appendix A.

After the interviews were transcribed, thematic analysis was used to evaluate the data. After familiarising, the essential insights from the interviews were highlighted. Thereafter this highlighted data was grouped into relevant themes. These themes are related to the main topics found in the background (see Section 2) and, additionally, complementary themes were identified. Finally, the insights of the thematic analysis are reported as results organised per themes in the following sections.

3.2 Practical experiences

Interviews with primary school teachers provided valuable insight into how they generally experience and manage lunch breaks.

3.2.1 Operational realities

A recurring topic was the importance of creating a calm environment during lunchtime, both for the children to focus on eating and for the teachers to be able to perform personal tasks. Some emphasised that complete silence during lunch allows children to eat in peace while also giving teachers a brief moment to eat and recharge. Although achieving complete silence can be challenging, the teachers noted that it is a habit that can be taught. The minimal rules teachers apply to create a calm environment, as indicated during the interviews, are that children keep seated on their seat, and no chatting unless you need help. If so, children may quietly ask their neighbour or teacher.

In classrooms, the interactive whiteboard (in Dutch called: '*digibord*') plays a role during lunch. Teachers often use tools as timers to provide a visual structure for the lunch period, such as an hourglass or an apple with bite marks to visualise the progression of time. Additionally, (educative) videos are frequently used, either starting immediately or after a period of time. One mentioned that this is usually "*Jeugdjournaal, or another educational program ... or a real movie from Netflix or something like that*". The teachers mentioned that the use of the video creates a structured moment where the teachers can finish their own lunch, prepare for the next lesson, or handle administrative tasks.

3.2.2 Tasks of the teacher

Moreover, the interviews reveal that primary school teachers take on a wide range of tasks during the lunch break. In Table 3.1 below, the main tasks of the teacher during lunch break are presented with an explanation.

Tasks	Explanation
Maintaining order and a calm atmosphere	Teachers must ensure that students eat their meals, remain seated on their seat, and avoid (excessive) talking. This often requires a teachers' constant attention. Some children do not feel like eating, don't start eating immediately or don't have anything to eat, all which requires teachers to monitor and encourage healthy eating habits.
Assisting children with practical needs	Teachers, especially who teach young children (grade 1-4), need to assist in things such as opening food containers or cups or handling minor incidents including spilled drinks or accidents requiring a change of clothes. Additionally, children frequently approach teachers with question, personal stories or simply seeking comfort, such as a hug since this is not possible during the educational hours. One interviewee even pointed out that she "*had to provide necessary support for a child with diabetes*".
Focusing on the educational aspect of the lunch	When videos are played, they strive to ensure that children engage with the content, as these videos are often intended to be educational. Additionally, one interviewee reported also trying to take time to walk around the classroom, discussing the content of the lunch boxes, and encourage children to start with their sandwiches before eating any side items.
Tasks for teachers themselves	They need to prepare lessons and gather materials for the afternoon classes. A task that also requires time, energy, and focus on top of the rest. Furthermore, for teachers who do not have a personal break away from the students, the children's lunch break is their only opportunity to eat while managing their other duties.

TABLE 3.1: Table with tasks for teachers during lunch break

3.3 Challenges

Despite the aspects that are going well, the findings highlight the ways in which teachers need to balance their own needs with those of their students, which can sometimes be quite a challenge. These challenges highlight the complexity of managing lunch breaks effectively. Teachers indicated during the interview that the primary difficulty is finding a moment of rest for themselves while performing their supervisory tasks, as mentioned before, especially when they do not have personal time away from the children. When teachers do have some time for their own, they indicated that handing over the class before and after the lunch can be challenging. Specific information about the children must be communicated beforehand, and afterwards teachers sometimes need to address unresolved issues or catch up on important developments.

Furthermore, watching videos during lunch does not always have the intended calming effect. In some cases, children react too enthusiastically, leading to a distraction rather than providing a structured, peaceful break. Lastly, maintaining silence can be difficult. One teacher reported that if she has to step away to get something or go to the bathroom, the classroom noise level often increases immediately, making it challenging to restore order upon returning.

Additionally, a crucial difficulty is ensuring that all children finish their meals within the allocated time. The contents of the children's lunch boxes also provide difficulties, as teachers sometimes need to encourage balanced eating habits. Teachers must closely monitor students, as some children are expected by their parents to eat everything in their lunch box, while other parents are less strict in this. However, it can be difficult to assess whether a child has eaten and drunk enough. The varying needs and preferences of different children further complicate this, as some children appreciate a quiet environment, while others prefer to socialise and chat during lunch.

Teachers expressed they aim to achieve certain goals during the lunch break but often have difficulties implementing them. One common goal is encouraging children to eat at a calm and mindful pace. While it was pointed out that teachers are trying to reassure the children that they have enough time to eat, they feel this approach could be improved by using more specific prompts, such as *"eat slowly, notice the taste of your food,* or *what did you eat yesterday"* to foster greater awareness. Additionally, teachers find it challenging to help children recognise when they are full, as societal norms often emphasise finishing everything on their plate. Encouraging students to listen to their own hunger cues rather than external expectations remains an ongoing struggle.

Another dilemma involves the use of television during lunch. Some teachers recognise that screen time is not the most beneficial option during eating, but adjusting this practice proves to be difficult for them. Watching videos provides a valuable moment of peace, which both children and teachers appreciate, making it hard to replace with an alternative. Finally, an interviewee highlighted the need for greater awareness and knowledge within schools about these issues. Providing more guidance and resources could help teachers create a more balanced and healthy lunch experience for both students and themselves.

3.4 Ideal lunch break

In an ideal scenario, the lunch break would be structured in a way that benefits both teachers and students, as expressed by the interviewees. One of the mentioned improvements in an ideal situation would be the presence of additional support staff, such as interns or teaching assistants, to help manage the lunch period. This would allow for a more balanced distribution of responsibilities and reduce the pressure on teachers. For teachers, a longer break would be highly beneficial as well. Ideally, they would have enough time to eat their own lunch, connect with colleagues, and organise their morning and afternoon lessons without feeling rushed.

Another key aspect indicated by the teachers is ensuring a calm and structured environment during lunch. Both students and teachers would benefit from a setting where children can eat in peace while teachers have a moment to recharge. For students, the lunch break should offer a healthy balance between eating, socialising, and physical activ-

ity. There should be enough time for children to finish their meals, engage in meaningful conversations, and have a moment to play and move around. Lastly, a focus on healthy food in the lunch boxes would be ideal to ensure that children develop good eating habits and receive the necessary energy for the rest of the school day.

3.5 Needs of the target group

When considering children in grades 1-4, it is essential to recognise their specific needs and developmental characteristics during lunch, as mentioned in Section 2.5. Insights from the interviews on the question about specific needs of young children highlighted that these needs can vary per child and even per day. However, the most mentioned aspect young children often require is, again, a sense of calm and relaxation during lunch. It was reported that children could benefit from a quiet and soothing environment, where elements such as soft background music which can help to create a more meditative atmosphere. Additionally, children need to focus on their lunch. Lastly, teachers observe that some students actively seek interaction with peers or the teacher during this time, emphasising the preferred social aspect of mealtime.

When looking at the development characteristics of the young children, it became clear that they rely heavily on visual cues to navigate their routines as number sense, time awareness, and literacy develop primarily in the latter half of this age group [68]. One teacher uses visual cards on the wall with symbols to communicate expectations easily, such as staying quiet or sitting properly. Another teacher expressed using physical cues, like a necklace with a 'quiet' symbol, to remind children of the expectations. In addition, children of such young age do not have a sense of time. Therefore, teachers noted that they use a visual concept of a timer, such as an animation of an apple with bites gradually being taken out until it is fully eaten, indicating that time is up, or colour-coded indicators on the clock. Furthermore, young children thrive on routine and predictability, especially regarding where and when activities take place.

3.6 Chapter conclusion and implications for the project

Based on the conducted interviews with the primary school teachers, several key insights have emerged regarding the challenges and needs during the lunch break. In this section, these findings are summarised and placed in a broader context by linking the most relevant takeaways to practical considerations and implications for the remaining of the project.

Teachers indicated that they have a lot of responsibilities during the lunch break. Because of the combinations of all these tasks, the lunch break can be quite challenging for the teachers. It is not possible to support teachers in every responsibilities they have during a lunch break, since some tasks can only be carried out by the teacher themselves. Maintaining order was the most important and recurring aspect of the lunch during the interviews. Teachers consistently mentioned the difficulty of ensuring that children remain seated, eat their meals, and avoid excessive talking and often use watching television to (partly) solve this issue. It became also clear that young children do need a calm atmosphere while eating. These insights suggest that the project should (among others) explore tools that promote calmness and routine during lunch while being simple for teachers to integrate into their existing practices and provide support for them.

Furthermore, teachers expressed their desire for encouraging and promoting healthy and mindful eating, which is of great importance as described in Chapter 2. However, in the current situation, achieving this effectively can be difficult for teachers. As can be concluded from the interviews, helping children focus on their meals while reducing teachers' supervisory burden is preferable.

These insights highlight potential areas where a possible intervention as solution could provide support. Moving forward, it can be concluded that the research should focus on enhancing both the calmness of the lunch period and children's engagement in healthy and mindful eating. The burden of all the responsibilities the teachers have during the lunch, as indicated during the interviews, should be supported and preferably reduced. This to ensure that the tools are both practical and beneficial for students and teachers.

Chapter 4

Related work

The idea of improving the communal lunch in primary schools for both children and teachers using technology is relatively novel. However, outside the school setting, the specific target group or the use of technology, there are some existing interventions. This section examines existing interventions in both research and practice, to learn from them and gain inspiration for the ideation phase. The focus is on strategies that promote healthy eating behaviour, and foster a calm environment. This since these are key priorities identified for the remainder of this project, as outlined in Chapter 3.

4.1 Eating behaviour

Various interventions have been developed to improve eating behaviour with different user settings. The existing interventions aimed at healthy eating behaviour that were found have been classified into three different categories: tangible technologies, in-person training programs, and mobile applications. For each category, examples of related work will be explored in the following sections below.

4.1.1 Tangible Technology

Tangible technology allows users to interact with digital information or systems through physical objects or touchable interfaces. With regard to healthy eating behaviour, several existing works have been found. There are food utensils available, such as smart cutlery with sensors which can measure how fast you are eating and even provide feedback [72, 73, 74]. The SmartPlate [75] (see figure 4.1) is a plate with sensors that analyses a meal by identifying and weighing your carbohydrates, proteins and fats to make sure one never overeats or under-eats again. Similarly, 'FunEat' [76] (see figure 4.2) is designed as an intelligent dinner plate system for children specifically. It is composed of gravity sensors in the plate and a projection device, which can provide guidance through interactive animation when children eat. Lastly, an attachment to a bottle called Ulla [77] (displayed in figure 4.3), which reminds you to hydrate if you forget and tracks when you drink. In addition to cutlery, multiple smart and interactive tables are also developed. For example, 'iEat' [78], an augmented and interactive table for restaurant customers. The table enhances customers' experience through entertainment, socialisation features and through interaction with physical objects placed upon the table surface. 'Dinner party' [79] is a similar intervention, which provides interaction between a person dining and objects placed on top of the table. Furthermore, the Sensory Interactive Table [80] is created which measures eating behaviour and interacts with diners through the use of embedded LEDs.

FIGURE 4.1: SmartPlate [75]

FIGURE 4.2: FunEat [76]

FIGURE 4.3: Ulla [77]

Lastly, various other tangible technologies are utilised to monitor and enhance healthy eating habits. The research of Nicholls et al. [81] investigated the development of a system for detecting eating behaviour using wearable Electromyography (EMG) sensors in combination with real-time wristband haptic feedback to facilitate mindful eating. Zhang et al. [82] developed a voice assistant to facilitate mindful eating activities using Google Nest Mini 2 devices.

4.1.2 In-person training programme

Mindful eating interventions have been widely explored in in-person training programmes in general, with most efforts directed at adults. These mindful eating training programmes, as described in various research [83, 84, 85, 86, 87, 88], typically consist of multiple in-person group sessions. Although the core principles remain similar, each programme differs slightly in its structure and implementation. To promote awareness and self-regulation (the ability to modulate one's behaviour), the sessions of these mindful eating training programmes cover topics on specific mindful eating concepts such as stomach fullness, taste satisfaction, or emotional eating. In addition, several interventions included mindfulness training, such as meditation, for stress management and emotion regulation [85, 87, 88], while other offered associated nutritional information as well [84, 86]. Multiple training programmes provided their participants with home practice guidelines for mindfulness and meditation exercises. [85, 87, 88] or a helpful list of resources [86].

While in-person training programmes are primarily targeting adults, research on child-focused and school-based applications remains a bit more limited but has a growing interest. Mindfulness-based interventions have been adapted for their use with adolescents and children [89]. For example, Kumar et al. [90] investigated a family-based mindful eating intervention in adolescents and Gayoso et al. [91] investigated with 8-9 year-old children who received mindfulness-based eating sessions. Some existing research has been applied in school settings. General nutrition education and workshops have been implemented as part of school-based initiatives to promote healthy eating habits [92, 93]. In addition to these broader educational programmes, one study specifically focuses on a school-based intervention fostering mindful eating practices as part of the curriculum among elementary school children and their parents [94]. In the study by Wylie et al. [94], the mindful eating curriculum included parent workshops on mindful eating, classroom activities led by nutrition educators, and take-home activities designed to encourage mindful eating practices at home with parents. This study included a 6-month curriculum and was positively received by students, parents, and teachers, although limited parental participation.

4.1.3 Mobile applications

Mobile applications are increasingly used as tools to promote healthy behaviours, including nutrition education and mindful eating practices. Several apps have been developed to enhance awareness of eating habits and encourage self-regulation. There exist text messaging-based mindfulness-based interventions which are posts/packages delivered via smartphones periodically [95, 96, 41]. These posts typically include an audio or video file along with homework practices, sometimes supplemented with additional textual information or questions-answer sessions.

In addition, there are self-paced mobile applications developed as well. These mobile apps all serve as virtual coaches guiding the user to gain control of their eating and enjoy their food. For example, 'Headspace', a meditation app, has a specific course dedicated to mindful eating [97]. Mobile application specifically designed for mindful eating are also available such as the app 'Way'[98] and the app used in the research of Mason et al. [99]. 'Lumme Health' takes it even a bit further by optimising for smartwatches as well with its innovative eating detection technology. Their mindful eating app offers a gamified experience from similar apps, including counting bites, measuring eating pace and estimating calories [100]. Lastly, the mobile game 'Time to Eat' [101] was designed for children. This app encourages healthy eating habits by engaging them in the care of a virtual pet.

4.2 Calm atmosphere

As became apparent during the interviews with the teachers in Chapter 3, creating a calm atmosphere is also crucial for an effective and enjoyable lunch break experience. A well-structured and soothing environment can help reduce distractions and support positive social interactions during lunch. This section explores various factors that contribute to a calm atmosphere, including the physical environment, technological interventions, and teacher-led strategies, such as mindfulness activities.

4.2.1 Environment

According to Watts [103, p. 11], "*tranquil environments can provide relief from stresses of everyday of life and can be considered restorative environments*". The use of decoration plays a crucial role in shaping the atmosphere of a space, thoughtfully designed environments can contribute to a sense of calm and well-being. There are studies indicating that indoor plants, for example, provide a number of benefits for health, well-being, and work performance, contributing to making the classroom a calm space for students and teachers [104]. As stated by Hiemstra et al. [105], who researched greenery in higher education, greenery has a positive effect on the health and general well-being of students and staff. In addition, it improves students' performance and their ability to concentrate, as well as improving the social climate [105]. There is also some art specifically designed to transform an indoor environment into sanctuaries of tranquillity. Such as the art of

FIGURE 4.4: Tranquillity art of Oswald [102]

Oswald [102], who captures the healing essence of the outdoors, bringing the serene and sublime into a space (see Figure 4.4).

Furthermore, colours incorporated into a space can affect an environments. Soft pastel hues are widely recognised for their calming effects, with yellow specifically associated with happiness and blue known to promote tranquillity [106]. Moreover, lightning can be taken into account. As mentioned by Rossi [107], exposure through a light source and its colours can induce different emotional states. Decorating with intentions would be advisable where distractions should be reduced as much as possible [104].

Besides, there are solutions for reducing or isolating from excess noise such as acoustic panels specially designed to absorb and insulate sound, thereby reducing the noise level in a room [108], as can be seen in Figure 4.5. There are even specific phone booths with high sound insulation [109] (see Figure 4.6). When looking at the school setting, setting up a so called 'chill out corner' in the classroom can provide a place for students who need to take some time away from their classmates. Providing students with outlets to use when they're feeling upset or angry will help them learn self-regulation and help maintain calmness in the classroom, as mentioned by Sager [104].

FIGURE 4.5: Acoustic panels [108]

FIGURE 4.6: Phone boots with sound insulation [109]

Lastly, playing calming music can be beneficial. Studies have shown that music has several positive effects on both the brain and body [110]. Music is proven to help reduce stress [110]. Furthermore, as described by Baker [111], music activates the areas of the brain involved with paying attention and maximize learning and improve memory. Using music in the classroom can thus move the brain to pay attention and focus, resulting in a calm classroom [104].

4.2.2 Technologies

There are also some technologies that exist as an intervention to create calmness. Weekly et al. [112] researched different smartphone application platforms for apps relevant to relaxation, mindfulness, and calming for the care sector. Apps reviewed often targeted mood and sleep patterns [112]. Additionally, haptics are used in existing interventions. For example, Sensate (see Figure 4.7) is a biohacking meditation tool that uses sound to create resonant frequency vibrations within the human body [113]. Chemelik [113] reported that it

"is beneficial for anxiety, panic attacks, depression and other mental health issues related to stress". Haynes et al. [114] researched something alike in the tactile domain. They demonstrate that haptic technology can offer an enjoyable, effective and widely accessible alternative for easing state anxiety with the use of a novel huggable haptic interface that pneumatically simulates slow breathing [114], as can be seen in Figure 4.8 below.

FIGURE 4.7: Sensate [113]

FIGURE 4.8: Huggable haptic interface [114]

4.2.3 Teacher strategies

Beyond the physical environment and technological interventions, teacher strategies and mindfulness activities also play a crucial role in fostering a calm atmosphere. This section explores how educators can actively contribute to a sense of tranquillity through structured approaches and mindful practices.

It is essential to incorporate social and emotional learning throughout the school year and equip students with strategies to help them regulate their emotions effectively [104]. There are a couple of teacher strategies to implement to foster a calm environment. It is of importance to set clear rules and expectations for students to implement positive reinforcement, utilise non-verbal cues, and foster positive teacher-student relationships [115].

On top of that, mindful activities can also contribute to creating a calm atmosphere. Mindfulness (the practice of being present and fully engaged in the moment without judgment) has gained significant recognition in educational settings for its numerous benefits [104] [115]. Concentration and tranquillity often go hand in hand with mindfulness, both during practice and in everyday life, potentially supporting overall mental well-being [116]. In the classroom, it supports both teachers and students in managing stress, regulating emotions, and enhancing concentration, which are effects that are essential for fostering a calm and focused atmosphere, allowing students to enjoy their meals without the disruption of overwhelming emotions or distracting behaviour [115]. Simple mindfulness techniques such as mindful breathing, mindful listening, body scan, and gratitude moments can help teachers create a more attentive and tranquil classroom environment [115].

4.3 Chapter conclusion

This related work section provides valuable information on existing interventions that promote healthy eating behaviour and a calm atmosphere, which are key priorities for this project. Tangible technologies provide interesting possibilities when it comes to eating behaviour. Smart eating utensils and interactive tables have been designed to guide and monitor eating habits. This could offer real-time feedback or engaging users through playful interaction. Beyond physical tools, in-person training programmes have shown promising results in teaching mindful eating, primary among adults but also some when children and even their parents are involved. This suggests that embedding mindfulness elements into the school lunch routine could help children develop healthier eating habits over time. Mobile applications emerged as effective tools for self-regulation on mindful eating as well. Some apps function as virtual coaches, while others gamify the process, making mindful eating an engaging experience.

Beyond eating habits, the research emphasises that a calm atmosphere is also important. A well-structured, soothing environment can be influenced by multiple factors. Studies suggest that greenery, soft colours, and intentional decoration contribute to a sense of tranquillity. Likewise, reducing excess noise through acoustic panels or dedicated quiet areas could help children focus on their meals rather than external distractions. Technology also plays a role in relaxation. From calming mobile apps to haptic devices designed to reduce stress, different tools exist to promote a sense of ease. Lastly, teacher strategies remain one of the most direct and influential factors in maintaining a calm environment, such as setting clear expectations and reinforcing positive behaviour. Additionally, incorporating mindfulness exercises could help reducing restlessness.

While no practical solutions exist that fully align with the school lunch setting, the findings highlight several technologies, interventions, and strategies from different domains offering inspiration for the ideation phase. Bringing these insights into the ideation phase, it is needed to consider how different elements, such as physical objects, digital support, environmental factors, and teacher involvement, can be combined to create a lunch experience that is both healthy and enjoyable. Some questions might arise. While many of these interventions focus on individual eating habits, how might we adapt similar principles to a collective school lunch setting? The idea of using digital guidance is often used, but how might it translate to the classroom setting? And could small environmental adjustments in the classroom make a noticeable difference in how children experience lunch?

Chapter 5

Design approach

The key question remains: how can we design an intervention that is both practical and beneficial for students and teachers in making lunch a more positive experience? This chapter translates the key insights gained from the conducted research and examines how these findings guide the design process. It serves as a bridge between research and design by translating the identified needs, challenges, and opportunities into concrete design objectives and requirements. These objectives subsequently shape the development of the design framework, ensuring that the design process is grounded.

5.1 Design objectives

Based on the findings from the conducted research, three primary objectives have been identified to guide the design process. These objectives ensure that the design aligns with user needs, practical constraints, and the overarching goals of the project. The identified objectives are to foster a calm atmosphere, support teachers in their tasks, and promote healthy eating behaviour for children. For an intervention to be an effective solution to the problem, it should meet all three objectives.

The first objective is that an effective solution must foster a calm atmosphere. During the interviews with the primary school teachers it became clear that both for the students as well as for the teachers it is highly preferred to have a calm atmosphere. In this way children can relax during the lunch break and can eat their lunch in peace. For teachers it means that they ensure a well-managed classroom and have some room for their (personal) tasks.

In addition, the second objective is that an intervention needs to be supportive for teachers, meaning reducing teachers' workload during the lunch break rather than adding new complexities. Teachers expressed their challenge duringch break with all the tasks they have to do, do,during the survey and interviews with teachers. A solution should therefore support teachers with some tasks that can be supported with the use of an intervention, and should not be adding additional time or energy consuming responsibilities.

Finally, a solution must focus on promoting a healthy eating behaviour among children. Since the current implementation of watching a video has a negative impact on the eating behaviour among children, as concluded in the research (see Section 2.2), it is of importance that the intervention fosters a healthy eating behaviour. Schools play a crucial role in fostering healthy eating behaviours, as they provide an environment where children,

who are in a critical stage of development, can develop a strong foundation for lifelong nutritional habits. When looking into what a healthy eating behaviour for children actually contains, it became evident that there are four important aspects: healthy diet, mindful eating, non-eating behaviours, and time (as described in Section 2.3). This can be regarded as an additional layer within the objectives, further refining the scope of the design challenge. To maximise the effectiveness of the solution, it is preferable to address as many of these healthy eating behaviour aspects as possible, ensuring a comprehensive and well-integrated approach.

5.2 Design frameworks

The design objectives are translated into a design framework that will guide the ideation phase. A design framework is basic structure that provide support to the addressed problem [117]. A framework facilitates understanding and focusing ideation on areas that matter. For this design challenge, a unique framework will be used, based on the collection of information and data in the research carried out before this phase which will be explained in the following sections.

5.2.1 Overarching framework

The three design objectives are used as categories for the overarching framework. A visual representation of these categories was created, for which a Venn diagram was utilised. A Venn diagram is used to order certain data. Venn diagrams typically consist of overlapping circles, with each circle representing some set of elements and overlapping regions between circles contain elements that belong to all overlapping sets [118]. The created design framework is displayed in Figure 5.1 below.

The region where the three circles overlap (outlined in red) represents the area of interest, as it signifies an idea that satisfies all three established objectives. If an idea meets one of the aspects of a healthy eating behaviour, it can be placed in the associated circle.

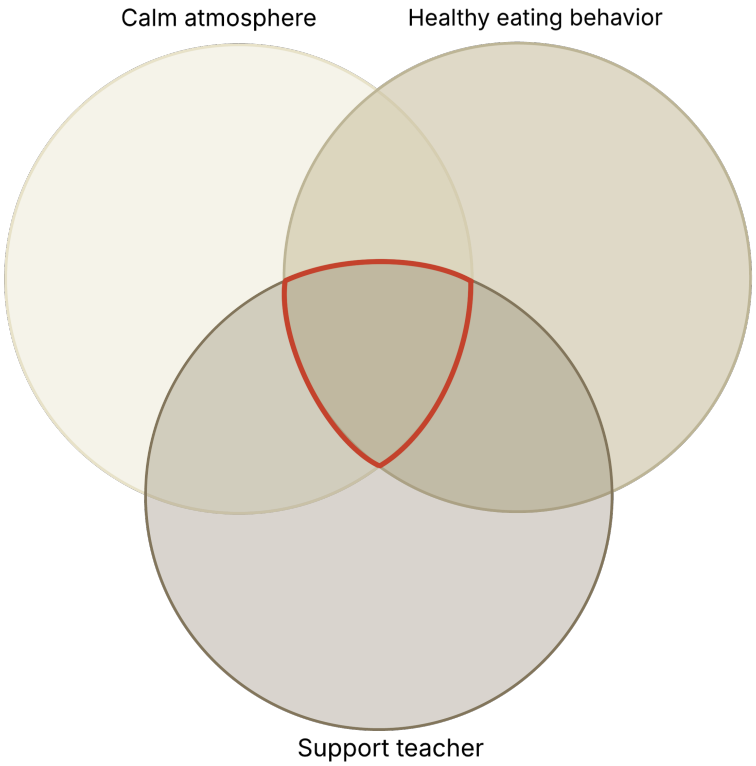

FIGURE 5.1: Overarching design framework

5.2.2 Detailed framework

As discussed in Section 5.1, besides the three design objectives, another layer within the objectives can be identified. This additional layer contains the four aspects of a healthy eating behaviour. For this additional layer, another design framework is made which will be called the detailed framework and can be seen in Figure 5.2. Again, a Venn diagram is employed with four sets of elements that contain the four aspects.

This framework will be implemented once the overarching framework is finalised, ensuring that an idea first addresses all three design objectives and secondly includes as many aspects of healthy eating behaviour as possible, preferably where the four ovals overlap (outlined in red), which represents the area of interest. This approach will maximise the effectiveness of the intervention in promoting healthy eating habits.

Two out of the four aspects of healthy eating behaviour identified in the literature could not be directly adopted as goals for an intervention. Therefore, these aspects were adapted to better align with the scope and possibilities of an intervention focused on teacher practices during a lunch break. The healthy diet aspect was reframed as educating children about healthy diet choices, since the actual contents of the lunch boxes are determined by parents and fall outside the influence of this intervention. Hopefully teaching children about a healthy diet, might be an indirect way to achieve healthy food choices. The time aspect of healthy eating behaviour was adjusted to focus on communicating available time to children. By doing so, the aim is to support healthy eating behaviour and promoting a calm and structured lunch routine.

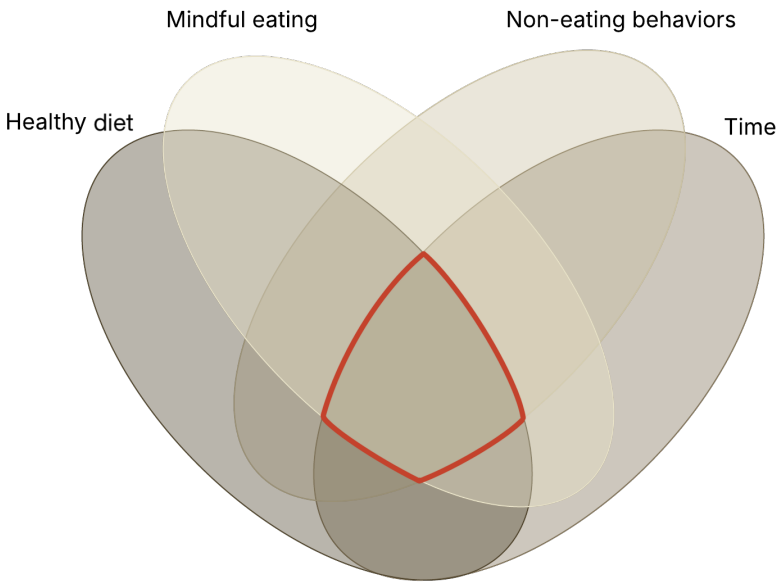

FIGURE 5.2: Detailed design framework

5.3 Requirements

To ensure that a possible intervention effectively addresses the objectives outlined in this research, a set of requirements have been established derived from various sources, including literature, user research, expert input, and logical reasoning. These requirements serve as guidelines that translate the research findings and design goals into actionable criteria. By adhering to these requirements, the design will be better align with user needs, practical constraints, and the overarching objectives of the project. In the following table (see Table 5.1), the requirements will be presented, including its source(s).

Number	Requirement	Source
1	A solution must foster a calm atmosphere.	Teacher interviews (*see Sections 3.4 and 3.5*) and expert interviews (*Research Topics* [14, p. 8])
2	An intervention must reduce teachers' workload during the lunch break rather than adding new complexities.	Teacher survey (*Research Topics* [14, p. 10]) and teacher interviews *(see Sections 3.2.2 and 3.3)*
3	An intervention must promote a healthy eating behaviour for the children by incorporating requirement 3a-3d.	Literature about the consequences of current implementation (*see Section 2.3*) and teacher interviews (*see Section 3.3*)
3a	An intervention should learn children about healthy diet.	Literature about healthy diet (*see Section 2.3.1*)
3b	An intervention should ensure that children eat mindful by focusing on the physical and emotional sensations.	Literature about mindful eating (*see Section 2.3.2*)
3c	A solution should accommodate non-eating behaviours by incorporating room for social interaction.	Literature about non-eating behaviours (*see Section 2.3.4*)
3d	An solution should communicate time division such that children can adapt their pace on that.	Literature about lunch timespan (*see Section 2.3.3*)
4	The intervention must be suitable for the development level of young children (ages 4-8).	Literature about target group (*see Section 2.5*) and teacher interviews (*see Section 3.5*)
5	The intervention should be appealing to young children.	Literature about target group (*see Section 2.5*)
6	The intervention should not distract children from eating.	Literature about the consequences of current implementation (*see Section 2.2*)
7	Implementation should be affordable for schools and not place additional financial or logistical burdens on parents.	Derived from practical reasoning
8	Teachers and staff should be able to use the intervention with little to no additional training	Indirect reasoning from teacher interviews on their daily routines and responsibilities (*see Sections 3.2 and 3.3*)
9	The intervention must be compatible with lunch breaks that may be designated as educational time.	Teacher surveys (*see Section 2.1.2*)
10	The solution should seamlessly integrate and fit in the existing lunch schedule without requiring major changes to daily routines.	Teacher interviews (*see Sections 3.2, 3.3 and 3.4*)
11	The intervention must be effective within the typical 15-30 minute lunch period.	Teacher survey (*see Section 2.1.2*)
12	The intervention should be sustainable over time and require minimal maintenance and updates.	Derived from practical reasoning

TABLE 5.1: Table with main requirements based on the design objectives

Chapter 6

Ideation

This chapter delves into the generation, iteration and evaluation of potential ideas to solve the problem of this thesis. To start, a brainstorm was performed to generate a wide range of ideas. Thereafter, an iteration with the conceived ideas was executed. The ideas were plotted on the design frameworks to make a selection of ideas that have the most potential to solve the problem as researched. Eventually, one final concept was selected that will be implemented throughout the remainder of the project.

6.1 Ideation method

This section describes the ideation method used to explore potential solutions, ensuring a structured, effective and iterative approach to the development of the concept. The ideation method is visualised and shown in Figure 6.1. First, a wide range of ideas will be generated during an unconstrained brainstorm. Consequently, these ideas shall be evaluated using the overarching design framework, as explained in Section 5.2.1. Thereafter, the ideas conceived are planned to be iterated on the basis of the SCAMPER method to make sure a significant amount of ideas achieve all main objectives. In phase 3, the remaining ideas will be evaluated again using the detailed framework with the healthy eating behaviour aspects. To meet as much healthy eating behaviour aspects as possible, another iteration is expected to be performed. In the next phase, the residual ideas will be analysed based on the established requirements (see Section 5.3). If necessary, ideas that do not fulfil the requirements will be excluded. Eventually, after reviewing the remaining concepts, a final concept will be selected.

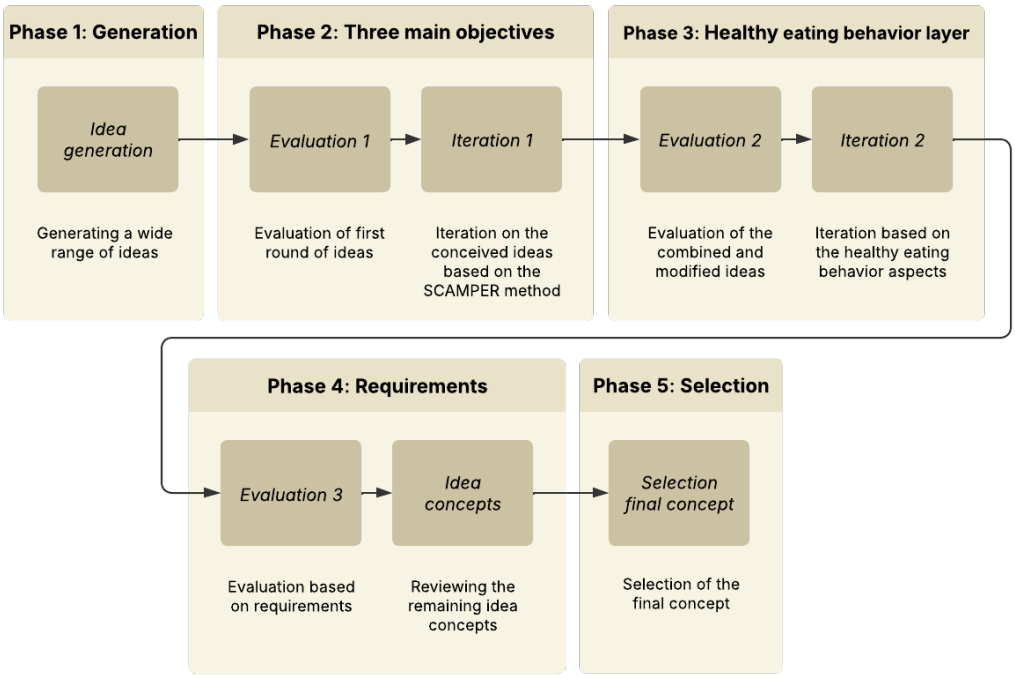

FIGURE 6.1: Ideation method

6.2 Phase 1: Idea generation

To develop innovative and effective solutions, it is essential to explore a wide range of ideas. Therefore, the approach was to generate as many ideas as possible without being limited by specific requirements. During the brainstorming process, all ideas were welcomed without immediate judgement. This unconstrained approach allowed for potentially more diverse ideas. The design goals as defined in Section 5.1 were kept in mind to ensure that solutions would solve the issues that are currently encountered. The entire list of ideas can be found in Appendix B.1.

6.3 Phase 2: Three main objectives

Once the brainstorming of ideas was completed, the ideas were mapped on the overarching design framework (explained in Section 5.2.1) to visualise which ideas satisfies which main objective(s) of this design challenge. By using the framework to guide ideation, ideas will be sorted and organised [117]. In Figure 6.2 below, the visualisation of the ideas mapped in the overarching design framework can be found.

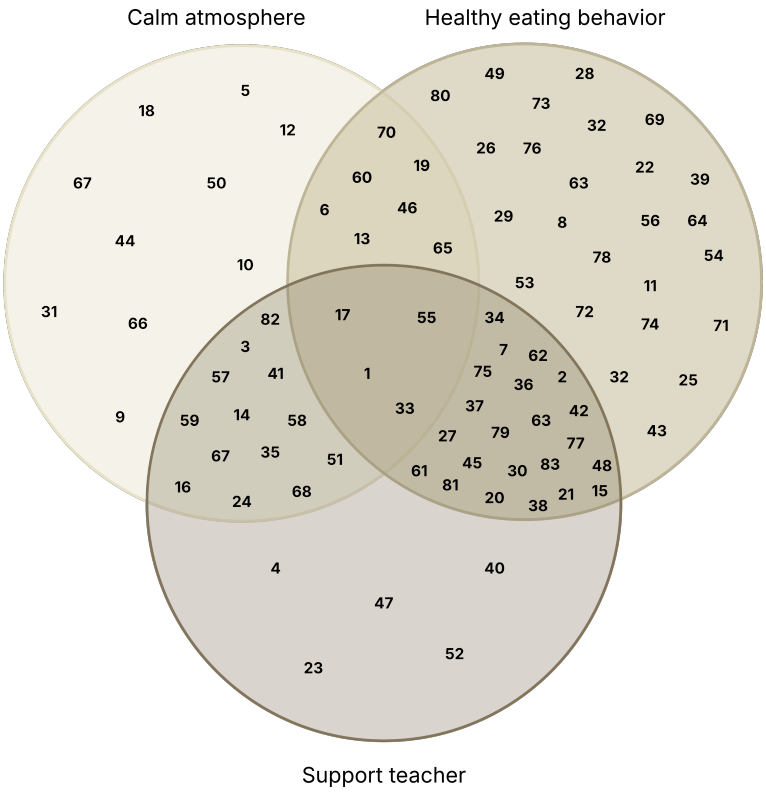

FIGURE 6.2: Brainstorming visualisation

It can be concluded from the filled in framework that the generated ideas were quite distributed, but most ideas were generated with the healthy eating behaviour in mind. In addition, a considerable number of ideas already are plotted in areas where two circles overlap. Still, the optimal idea would be placed in the 'area of interest', where the three circles overlap, implying that an idea satisfies all three main objectives. As can be seen in Figure 6.2, a couple of ideas are currently placed in the desired region.

However, it is observed that there is still quite some potential with the other ideas outside the region of interest. Ideas that currently are not meeting all three objective can still contain good elements that can be used in a potential solution. Therefore, an iteration round is performed. In this phase, the SCAMPER method [119] is employed to challenge and transform existing ideas. By substituting, combining, and modifying elements of current ideas, more ideas could be mapped into the desired area on the design framework. Whereas the idea generation phase encouraged an open-ended exploration to generate a diverse range of ideas, from this phase onwards the requirements (see Section 5.3) were considered throughout the process. This shift ensured that the developed concepts were already a bit aligned with feasibility constraints and involved stakeholder needs. The list of these ideas from this iteration is documented in Appendix B.2.

6.4 Phase 3: Healthy eating behaviour layer

Moving on to phase 3 of the design process, the "renewed" ideas after iteration and the ideas already in the desired area (both with new numbering) are then plotted on the overarching design framework again, as can be seen in Figure 6.3 below.

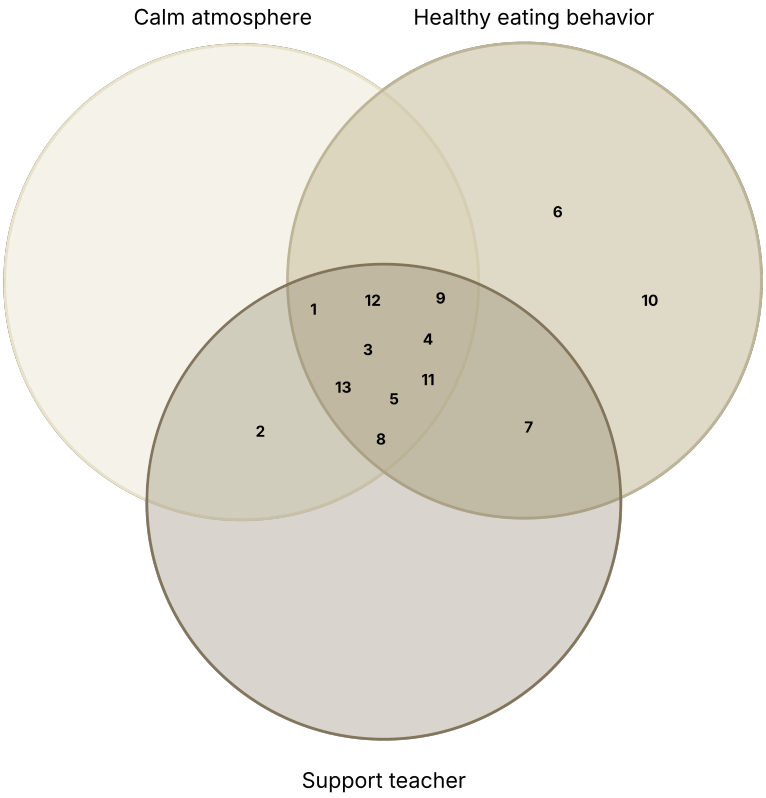

FIGURE 6.3: Second iteration

From this figure, it can be concluded that after the iteration there are now nine different ideas that achieve all three main objectives. These nine ideas will be taken forward to the next step of the process. As has been observed in Chapter 5, within the objective of a healthy eating behaviour, another layer of aspects can be derived. Therefore, the next step is to map the nine remaining ideas in the detailed design framework to see how many aspects are achieved with a certain idea. The visualisation of this filled in detailed framework can be found in Figure 6.4 below.

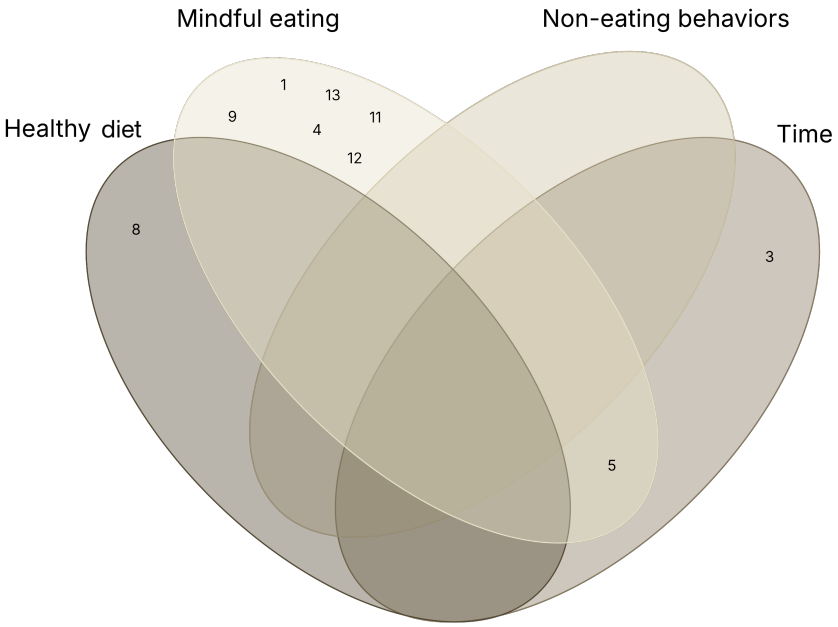

FIGURE 6.4: Remaining ideas plotted on the detailed design framework

As can be concluded from Figure 6.4, most of the ideas cover only one aspect of a healthy eating behaviour. Mindful eating emerged as the most frequently addressed aspect of healthy eating behaviour. This emphasis is likely due to the current situation in which mindless eating (the opposite of mindful eating) is a commonly observed problem, as concluded in Section 2.2. As such, it was on the top of mind during brainstorming sessions, leading to a natural focus on interventions that encourage greater awareness and attention while eating.

In contrast, non-eating behaviour was a relatively under-represented aspect in the ideas generated. One possible explanation is that addressing non-eating behaviour can easily conflict with other design goals, such as maintaining a calm and relaxed atmosphere during lunch. However, this aspect remains important in supporting healthy eating habits. When carefully considered, non-eating behaviour can be designed in a way that complements rather than disrupts a calm atmosphere. Incorporating it with intentionality and balance can enhance both the eating experience and the lunch environment.

To have to most effect on the healthy eating behaviour of the children, it is preferred for an effective solution to cover as much aspects of a healthy eating behaviour. For this reason, it is chosen to perform another iteration. During this iteration, each idea from the remaining nine will be evaluated to check the potential to cover more aspects. If possible ideas will be adapted in a way that they cover more aspects and thus lay in an area where multiple circles overlap in the detailed design framework, preferably the one in the middle where all four circles overlap. In this way, an idea for an intervention covers healthy diet, mindful eating, non-eating behaviour and time aspects of a healthy eating behaviour. For the ideas that could be adapted, an adapted description of the ideas can be found in Appendix B.

6.5 Phase 4: Requirements

Upon completing the second iteration, phase 4 could begin. The adapted ideas of the second iteration were plotted on the detailed design framework again, as can be seen in Figure 6.5 below, to see which ideas lie in the area(s) of interest and are thus the ideas to move forward with.

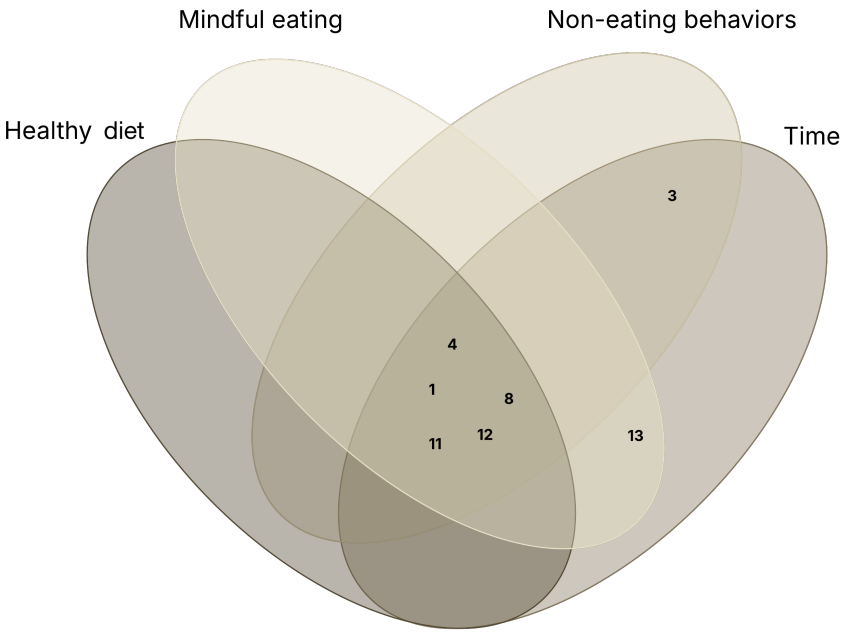

FIGURE 6.5: Ideas after iteration 2 plotted on detailed framework

The filled in detailed design framework demonstrates that there are five ideas that are in the preferable area meaning they meet all the four healthy eating aspects. After evaluating the remaining ideas, it became evident that one idea (number 4) was not realistic and feasible in the context. A brief analysis confirmed its infeasibility within the given constraints (see requirement 7), leading to its elimination. Consequently, four ideas remain for further development, which will be elaborated in the next section.

6.5.1 Idea concepts

The first concept revolves around a stuffed animal/mascot that engages children in a storytelling experience during mealtime. A concept sketch can be found in Figure 6.6. This stuffed mascot features an audio component that narrates stories while seamlessly integrating elements that promote mindful eating. Throughout the meal, the mascot provides gentle time indications and encourages children to pace their eating, for example. Additionally, it could share fun and educational facts about healthy diet intertwined in the story, fostering awareness of nutritious choices. As the meal progresses, the mascot poses thought-provoking questions to stimulate reflection on eating habits, gradually shifting focus towards the social aspects of dining near the end. This concept can create an engaging and age-appropriate experience that resonates with the target group, making mealtime both educational and enjoyable.

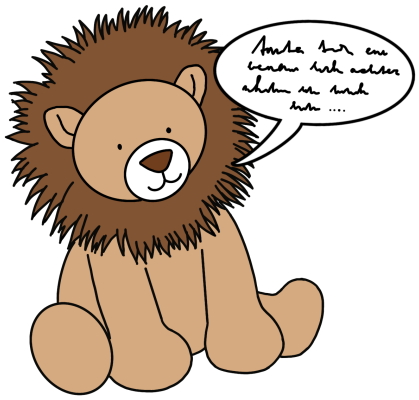

FIGURE 6.6: Concept 1 sketch

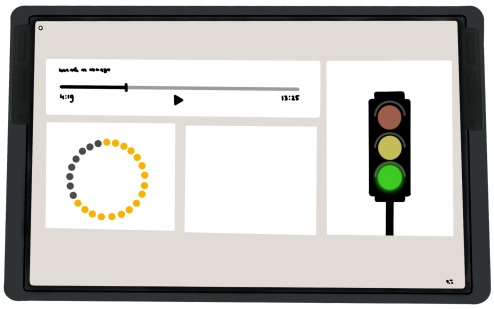

FIGURE 6.7: Concept 2 sketch

The next concept involves a website/dashboard designed to support mindful eating in the classroom, which can be displayed on a so called Digibord (which is often already present in most classrooms) for collective engagement. The platform can feature an audio component, including soothing background music to create a calm eating environment and narrated stories that integrate mindful eating questions and educational information about healthy diet. Additionally, an interactive sound measurement feature can be added to encourage children to be mindful of noise levels during meals with, for example, the use of the traffic light principle. Moreover, a visual timer could provide a clear indication of lunch time, helping children develop a better sense of meal pacing. A sketch of the concept can be found in Figure 6.7. To enhance engagement, users can also select different themes to match classroom preferences. The platform can ensure ease of use and clarity, making it a practical tool for educators.

This third concept features a flat screen, designed to be used at the table group level during mealtime. The device provides visual guidance through the use of icons, supporting children in developing mindful eating habits, as has been visualised in Figure 6.8 on the right. It could help structure the meal by indicating the eating order, ensuring a thoughtful approach to food consumption. In addition, the device can promote social interaction by incorporating prompts/icons that encourage conversation and engagement among children. A time indication feature with a circle of LEDs around the device helps regulate the pace of eating. The distinctive group-based approach improves collaboration and shared responsibility, making the concept interactive and engaging for young learners.

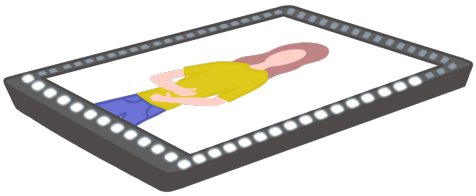

FIGURE 6.8: Concept 3 sketch

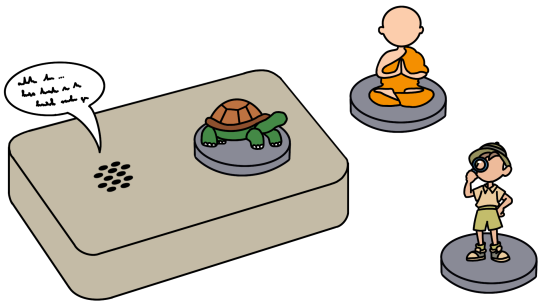

FIGURE 6.9: Concept 4 sketch

The last concept introduces an interactive device that uses figures/puppets embedded with RFID tags, each representing a different mindful eating aspect. For example, a turtle puppet eats and chews slowly and mindfully while an explorer puppet likes to explore new flavours and foods. A sketch of this concept is made and can be found in Figure 6.9. By placing a figure on the device, children activate an audio experience that includes a storyline with a focus on that specific mindful eating aspect interwoven in the storyline, along with educational facts about healthy diet. The device also incorporates elements that highlight the social aspects of eating, encouraging interaction and reflection. An audible time indication feature could help structure the meal and guide children to pace their food. What makes this concept distinctive is its focused approach, which allows each session to emphasise a specific aspect of mindful eating with the corresponding figure, making learning more targeted and engaging for children.

6.6 Phase 5: Selection

In the last phase of the ideation, a final concept will be selected from the four idea concepts presented in Section 6.5.1. As all four of them align with the design objectives, since they were preselected on that basis. Therefore, the ideas were primarily evaluated against the requirements and the pros and cons of the idea, to identify the most effective solution. Supervisor feedback was also incorporated.

It became clear that with idea concept 1 and 4, it was missing that it is not able to complement the story with something visual which can be preferable for children of young age. Ensuring alignment with children's developmental level is crucial, as reflected in the associated requirement. In addition, when using audio or spoken story, a few considerations were highlighted. The audio can provide structure to the lunch break, which is desired for

children and has a positive effect on the calm atmosphere. Concept 1 is limited in variation which raises concerns on the effectiveness over a longer period of time. Moreover, it was questioned if concept 1 appeals to the whole target group, including the older children.

An evaluation of idea concept 3 reveals that, compared to the other concepts, it requires the highest workload on teachers, which is not preferable of course. Moreover, this concept is considered high in costs and leads to distraction from eating (available on each group of tables, attraction to interact). Furthermore, idea concept 2 was considered a bit standard and boring for children. The screen displays too much information at once, which causes excessive distraction from eating. However, it was recognised for its ease of use. Looking at idea concept 4, having a tangible element is a valuable aspect and can appeal to children. The specific mindful eating aspect associated with a certain puppet may be somewhat limiting, but has potential for extension of puppets with different themes.

Eventually, after evaluating the ideas against the requirements, the final concept will be a slightly adapted combination of idea concepts 2 and 4. The final concept thus exists of a device where puppets can be placed on to start a story with the aspects of healthy eating behaviour integrated. In addition, to provide visual aid for children and to easily manage everything for the teachers, an application will be displayed on the 'digibord'. This combination was chosen because it is possible to visualise things with regard to the audio story for the children but there is also something tangible which appeals to children. A further elaboration of the product design specifications is provided in the next chapter, which delves deeper into the explanation and specifications of the chosen final concept.

Chapter 7

Conceptual design elaboration

Following the ideation phase with the evaluation of various concepts, this chapter provides a detailed elaboration of the selected concept. By specifying the scenario, its functionality, user interaction, and technical considerations a well-defined design will be accomplished. This chapter bridges the gap between concept generation and prototype development by further developing the chosen approach.

7.1 Concept design

The selected concept is based on the insights of research and previous design iterations. The final concept is derived from a combination of two idea concepts (as stated in Section 6.6), incorporating minor adjustments to enhance effectiveness. The final concept consists of an interactive device with physical figures that represent different characters. The concept has a thematic approach to fit the experience world of the target group. The figures can be detected by the device. By placing a figure on the device, an audio-based storytelling experience will be activated that will guide the children through lunch with mindful eating activities, indication of time, social interaction and healthy eating education incorporated. In addition, a digital web application can be displayed on the Digibord providing visual support for children and supervision support for teachers, ensuring clarity and ease of use. A sketch of the final concept can be found in Figure 7.1.

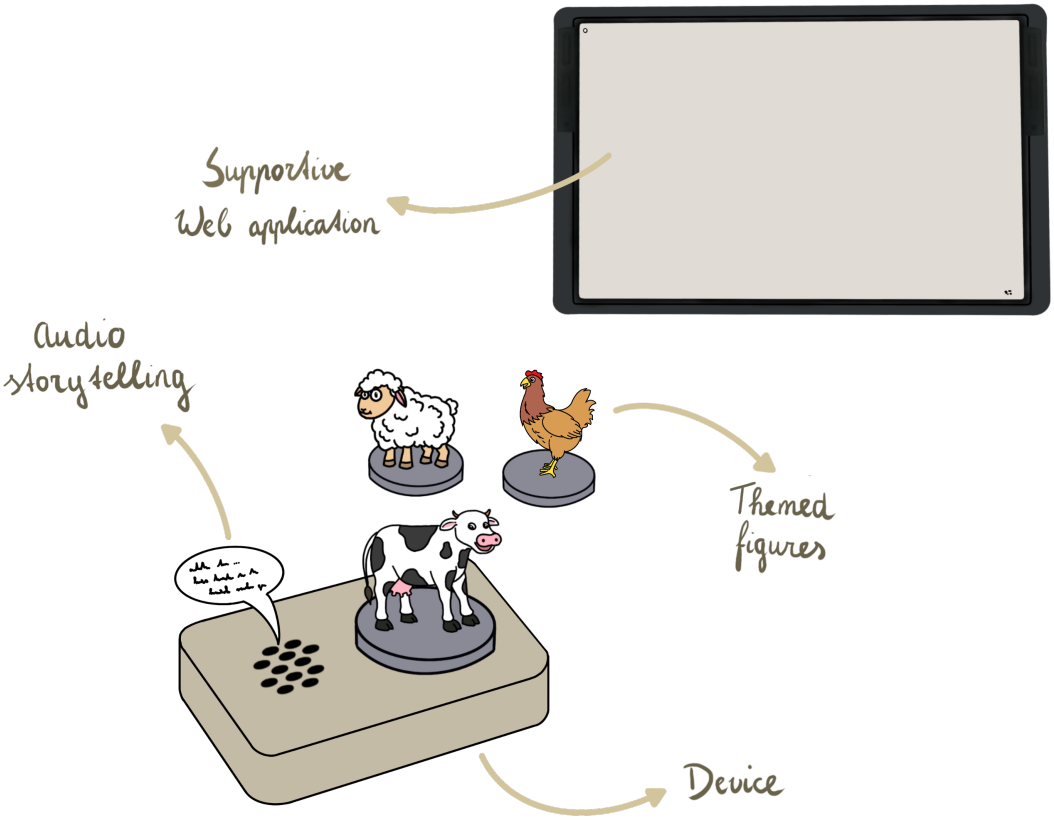

FIGURE 7.1: Final concept

This concept can be defined as a multimodal interface consisting of a tangible interface and a graphical user interface [120]. The tangible interface uses sensor-based interaction, where physical objects are coupled with digital representations [121]. In this case, RFID technology in the figures represents digital storytelling audio. A graphical user interface (GUI) is a computer program that allows users to interact with a computer using symbols, visual metaphors, and pointing devices [122]. In the next sections, a more detailed explanation of the functionalities, user interactions, and technical considerations of the final concept will be provided.

7.2 Scenario

To illustrate how the concept would function in practice, the following scenario describes a realistic use case of the intervention within its intended classroom context. It provides insight into how the intervention fits into the daily routine of its users, supporting both children and teachers, and reinforces the goals of this study. This scenario is based on the assumptions and findings gathered during earlier user research.

In this primary school, the lunch break lasts 30 minutes in total. The first 15 minutes are allocated for eating, which takes place in the classroom, while the remaining 15 minutes are used for outdoor play. The intervention is designed specifically to support this structure by helping children eat calmly and attentively within the designated eating time. When it is time for lunch in a primary school classroom, the teacher initiates the lunch routine by setting up the intervention. The tangible part of the concept will be brought

out and placed it in the front of the classroom as part of the routine to mark the start of the lunch break. Additionally, the teacher launches the user interface on the Digibord. The 'helper of the day' (a rotating role assigned to a student) activates the audio story by selecting an animal figure and placing it on the device. This action triggers a class-wide, farm-themed audio narrative, accompanied by a static visual on the Digibord. The story begins with a gentle instrumental tune, followed by an introduction from the animal character, who sets light behavioural guidelines to help maintain a calm atmosphere. The children, already familiar with the routine, open their lunch boxes as the story begins.

Children listen to the story while eating, without needing constant teacher guidance. The narration subtly weaves in elements of healthy eating behaviour pronounced by the character in the story. This helps shift the children's focus calmly engaging with their meal. Throughout the story, the teacher is mostly hands-off. The teacher occasionally glances around but doesn't need to intervene that much. Occasionally, the teacher assists some children with opening bottles for example, but overall the audio guidance supports self-regulation. Midway through the 15-minute eating period, the children receive a gentle time indication to help them regulate their eating pace and complete their meal on time. A visual progress indicator is also continuously displayed on the Digibord throughout the session.

A few minutes before the end of the lunch break, the story includes a brief moment for soft social interaction. The character poses a question related to healthy eating, prompting the children to discuss quietly with their neighbours. After a brief pause, during which no narration occurs, a gentle musical cue plays, signalling that the story will resume. The story then gradually winds down, marking the transition toward the end of the lunch period. The teacher uses this natural break to begin the clean-up routine. The children respond calmly and without resistance, having experienced a structured and soothing mealtime. Once the story ends, the teacher tidies up the intervention, and the children prepare to go play outside for the remaining 15 minutes of their 30-minute lunch break.

7.3 Functional description

It follows that the concept integrates multiple functionalities to enhance the experience at lunchtime. The combination of these functionalities ensures that healthy eating behaviour is encouraged in children, a calm atmosphere is fostered, and the teacher will be supported. The following provides a detailed exploration of the functions, systematically describing each aspect of the functionality of the concept.

7.3.1 Tangible interface

The functional description of tangible interface can be divided into three main functions: the interactive figures, device, and audio storytelling. Below, they will be explained on a functional level.

Interactive figures
As a thematic approach was chosen, the figures should represent characters from that theme. This because it is engaging for the target audience and aligns with the experiential world of young children. Each figure experiences adventures which the character tells as a narrative. Placing a figure on the device triggers one of the stories from the corresponding

figure since the specific figure will be detected by the device.

Device
The core functionality of the device centres around the interaction between physical figures and the system's embedded electronics. A dedicated device is for this purpose part of the concept. A designated area on the device surface is equipped with an RFID reader, enabling the detection of figures that contain integrated RFID tags in their base. When a figure is placed on this spot, the system recognises the corresponding unique identifier (UID) and triggers the playback of a pre-assigned audio story through the built-in speaker, such that the device can work independently. To provide immediate visual feedback and confirm successful detection, an indicator is added.

Audio storytelling
A narrative will be told class wide by the character about an adventure he has experienced. Each story has its own unique focus to ensure that children are not being flooded with information. The story aims to engage young children by immersing them in a familiar and relatable setting while introducing them to topics such as healthy diet and mindful eating in an entertaining and educational way. Every story would follow the same structure, which provides consistency, enhancing the calmness and comprehension of the children. The structure will be as follows:

- *Introduction*: First, the story will start with an introduction. In this introduction, the character will briefly introduce itself and the story, setting ground rules for during the lunch break, and provide instructions that children can start eating.

- *Story with healthy eating aspects incorporated narratively*: The story is based on an adventure the character has experienced. Several aspects of a healthy eating behaviour will be naturally woven into the story:

  - Learn about healthy diet: As mentioned before, with the intervention and its goal it is not possible to change the content of the lunch box, however it is aimed to teach the children about healthy diet which could hopefully indirectly influence the content of the lunch box in the future. When children are taught healthy habits, they are more likely to carry them into their home environment. Therefore, during the story, a fact or some information about healthy diet will be implemented.
  - Mindful eating: In addition, mindful eating will be integrated into the story in a subtle and passive manner. This means that mindful eating will be naturally woven into the narrative, allowing children to absorb these concepts without explicit instruction or active questioning. It is chosen to implement it passively during the story in order to keep a calm atmosphere such that children can focus on their eating.
  - Time reminder: Halfway through the story, a time reminder is provided such that children know they are midway their lunch break and should have eaten approximately half of their meal.

- *Social aspect towards the end*: At the end of the adventure, the character initiates social interaction. By incorporating questions related to healthy eating behaviour, the intervention encourages an active and reflective engagement with the topic. Questions that can be asked are for instance: what is your favorite fruit? or What item

in your lunch box did you enjoy and why? Incorporating these interactive elements, the story fosters engagement and a sense of community during lunch. Children are encouraged to talk softly with their peers about certain provided topics.

- *Closure*: At the end of the story when the lunch break is over, the character closes the story.

As research suggests, storytelling is a useful tool for facilitating understanding in the classroom, which goes beyond entertainment purposes and creating interest [123]. While storytelling can be entertaining and relaxing, it has the advantage of communicating narrative structures as well [124]. It provides a model of speech, a context for learning, and a way to expand imagination, which are beneficial for literacy development for children [124, 125].

The impact of reading aloud increases when elements of repetition are included [126]. Repetition plays a key role in a child's cognitive development. It is essential for learning, since the child's brain is actively engaged [127]. With each repetition, new information is stored [127]. Repetition not only helps children learn more words, but it also deepens their understanding of those words [126]. Children benefit particularly from varied repetition. Seeing the same content several times, presented in slightly different ways, helps children absorb the information more effectively [128]. Another reason young children enjoy repetition is that it creates a sense of predictability, which feels safe and comforting [127]. Repetition appeals to young children [128]. Repetition allows them to recognise the structure of a story and begin to predict how it will end [128].

Therefore, the concept intentionally incorporates elements of repetition. Although the intervention aims to offer a variety of stories to maintain engagement and cover a wide range of food-related themes, repeated exposure to the same stories can also be beneficial, as explained previously. In addition, key messages of healthy eating aspects interwoven in the stories are intentionally included across multiple stories, This since it aligns with research showing that varied repetition, where the same content is presented in different contexts, enhances comprehension and recall which is the goal.

7.3.2 Graphical user interface

Next to the tangible interface, the concept includes a graphical user interface in the form of a supportive web application. This application provides visual support for children and allows teachers to control and monitor the intervention.

Pupils section
The pupils section contains the following elements for support during lunch break:

- Visual support for story: In the web application visual support related to story will be shown. It provides additional information in the form of visual details, serving as support for the story being read [126]. This helps children better remember difficult or unfamiliar words and gain a deeper understanding of the story [129]. The visual support is intentionally kept as static as possible to maintain focus and minimise interference with the primary activity of eating.

- Time indication: A subtle time management system ensures that children pace their speed of eating appropriately. The time indication will be a visual representation, since not all children of the target group are able to tell the time.

- Visualisation of rules: Icons visualising the rules during the lunch break are displayed in the graphical user interface to provide clear, age-appropriate reminders that support consistent behaviour and foster a structured eating environment.

Teacher section
The teacher section for supervision support during lunch break includes the following components:

- Audio control functions: As part of the supportive web application, there is a dedicated teacher section that includes some audio control functions. These features allow teachers to manage the story-related audio, such as pausing, rewinding, or adjusting the volume to suit the classroom environment. This ensures a flexible experience, enabling teachers to adapt the audio to the needs of their class.

- Settings: Besides some audio control functions, there can be some other settings teachers can control as well. Settings that could differ per class can be set up by the teacher, such as the age of the children.

7.4 User interaction and experience

This section outlines the user interaction and experience with the concept, detailing the ways in which children and the teacher engage with both the physical components and the digital elements of the concept during their lunch break.

7.4.1 Tangible interface

In this section, the interactions and experience with the tangible interface part of the concept will be discussed.

Interactive figures and device

The interaction with the interactive figures should be small, intuitive and aligned with the children's world of experience, ensuring that it feels natural, engaging, and easy to understand. Either the teacher or a child, depending on what is preferred within the class routine, can select a figure from the available set of characters. Some primary school classes incorporate the concept of a 'hulpje van de dag', a designated child who supports the teacher by performing small tasks throughout the day. Integrating the action of selecting and placing the figure on the device into this role can enhance a more engaging and participatory lunch experience. When the physical figure is placed in the designated place, the embedded sensor mechanism detects this interaction and triggers a digital response with the start of the audio story.

Storytelling

The storytelling component of the intervention is designed to actively engage children during lunch while gently guiding their attention toward healthy eating behaviours. Children listening to the story is considered the key interaction within the concept. The story will be presented as an audio narrative, allowing children to listen while eating without the need for active interaction. It is a passive and low-effort interaction for the child that will be guided through the lunch moment in a structured manner, while minimising the need for complex user actions.

To support the goals of the intervention, the story is interwoven with carefully crafted story prompts, subtle moments within the narrative that mention healthy diet facts, or focus on physical or emotional sensations as part of mindful eating. These cues serve as soft interventions that help redirect attention when focus may drift, encouraging children to stay engaged with both the story and their meal. These narrative elements are designed to be seamless and non-intrusive, supporting the natural flow of the story while reinforcing the desired behaviour.

7.4.2 Graphical user interface

The graphical user interface contains a visual support part for children and a supervision support part for teachers. Below, in the sections that follow, the user interaction and experience of the two parts will be explained in more detail.

Visual support children

As part of the graphical user interface, visual support for children can be provided on the digibord to enhance the storytelling experience during lunch. The visual support on the digibord functions as a passive yet meaningful interaction: it complements the audio story while maintaining a quiet, distraction-free lunch atmosphere.

The design of this visual support should carefully consider the context in which it is used, during a mealtime setting where the primary focus should remain on eating. Therefore, the visual should kept simple and static, functioning as a supportive background. It presents a still image of the scenery of the story, with minimal essential animations or moving elements. The imagery would be designed to be relatable and engaging for young children, aligning with their world of experience while not demanding active interaction. This minimises cognitive distraction and helps to maintain a calm and focussing on eating environment.

In addition to the story scene, the graphical user interface for children also visually represents the remaining time of the lunch break. The design aims to prevent distraction or stress in children by maintaining a calm and unobtrusive presentation. This gentle indication helps children develop a sense of time, eat at an appropriate pace, and finish the food they need in time. Furthermore, there are icons added to the visualisation to support the rules during lunch break. These icons will be designed to be as simple and clear as possible, effectively conveying the rules. Teachers can interact with them as well, by referring to them when necessary to remind children of the expected behaviour.

Supervision support teacher

The teacher supervision support interface will be designed to support a quick and intuitive interaction, minimising cognitive load and setup time. Through a small dashboard, teachers can control the audio story with the dynamically changeable button to pause or resume depending on the playback status, as well as control story progression and volume with the corresponding buttons. All essential functions are presented with clear buttons and icons that require minimal explanation. The interface is structured to minimise the number of actions needed to complete a task, reducing friction in real-time use. The teacher supervision support interface will be accessible via a single-click collapsible panel at the bottom of the screen to avoid clutter on the screen with visual support for children.

7.5 Technical considerations

To ensure the feasibility of the concept, several technical aspects must be taken into account. These technical aspects will be briefly discussed below, with further details provided in the next chapter (see Chapter 8).

- RFID technology: For the device to be able to check which figure is chosen, RFID technology will be used. An RFID tag will be placed within the figure and an RFID sensor that can read an RFID tag will be included in the device. This enables seamless recognition of figures.
- Audio playback system: An audio playback system needs to be embedded in the device to provide clear storytelling. For this a speaker set up is required, and the correct audio file needs to be activated when a figure is placed on the device.
- Visual dashboard: For the supportive web application, a web-based interface needs to be developed that can be displayed on the Digibord.
- Power and connectivity: The device must be battery-powered or have a charging station to be able to turn on and function. In addition, the Digibord interface should function wirelessly in connection with the device.

Chapter 8

Prototype development

This chapter describes the development process of the prototype, which was constructed to serve as a functional representation for testing and evaluating the proposed concept. The prototype was designed to capture the main interactive and narrative elements of the concept while considering practical constraints such as available resources, technical feasibility and time. Based on the survey results regarding lunch break duration from teachers, the prototype will be designed around a 15-minute intervention. The sections that follow explain the key differences between the original concept and its physical realisation, the design and technical specifications of the prototype, and the limitations encountered during development that may influence the interpretation of the evaluation.

8.1 Differences concept and prototype

The core goal of this prototype was to be able to test and evaluate the proposed concept itself. Therefore, some compromises were made along the way. First, the concept can contain multiple themes, for the prototype only one theme was chosen and elaborated, namely 'the life on the farm', this to fit the world of experience of the target group (young children). Moreover, a single complete story with its associated visualisation for visual support has been developed, due to time constraints and the choice to focus on evaluating the quality, impact, and, most importantly, the potential of the concept, rather than the quantity of content. For illustration purposes, a couple of animal figures were developed as part of the prototype with this theme. In reality, there should be developed some more animal characters on the farm for more diversity.

8.2 Tangible interface

In this section, the prototype of the tangible interface will be described in therms of the different parts, including the physical design, the storytelling audio, the hardware, and the software. Figure 8.1 shows the tangible interface prototype.

FIGURE 8.1: Tangible interface prototype

8.2.1 Physical design

The physical design of the tangible interface of the prototype includes a 3D-printed case and a set of 3D-printed tactile figures representing characters and stories. Some of the 3D-printed components used in this prototype were sources from the online platform 'Thingiverse'. On that platform openly shared 3D design are available for reuse. These elements were selected based on their suitability for the intended use. In addition, several parts were self-designed and modelled or adapted when necessary. This was accomplished using the 3D software Blender, allowing for customised parts and the combination of multiple parts.

The case securely houses the electronics with dedicated holders for the different electronic parts to organise the inside of the box and ensuring different electronics are placed on the desired positions. In addition, on the top of the case a circular recess is designed where the figures (with their circular base) can be placed to initiate the story. Besides this, a speaker opening was integrated into the top of the case and covered with acoustic fabric to protect the component while allowing sound to pass through effectively. Furthermore, on the side of the case, a little hole for an indication LED and a little hole for the cable connection of the Arduino are created.

Figures representing animal characters were intentionally chosen to appear as childlike and approachable as possible, using simplified shapes and friendly features to enhance their appeal and relatability for young children. The figures are designed with a circular base, allowing them to be easily grasped by children and accurately placed onto the corresponding recessed area on the device to encourage an intuitive interaction. A dedicated compartment for the RFID tag was integrated into the bottom of each figure's circular base, enabling seamless identification when placed on the device while maintaining the visual and tactile preferences of the design. Since the figures emerge from the 3D printer

in a single colour, they were hand-painted to bring them to life and enhance their visual appeal, ensuring they align with the imaginative world and developmental experiences of young children.

8.2.2 Storytelling audio

For the prototype, one story has been fully developed as an example to enable evaluation of the concept. Given the absence of formal training in story writing, the story was developed with the assistance of ChatGPT. Based on a provided detailed outline of the story, different structured story prompts, the goal of the story, and the specific target group, the tool was guided to generate a coherent and engaging narrative tailored to the goals of the prototype. The story that was generated was afterwards adapted to create the most fitting and appropriate story for its purpose. The full script of the story can be found in Appendix C.

The story will take place on a farm, as it provides a rich environment where farm animals can embark on various adventures, many of which naturally connect to themes as food and nature. The story narrates an adventure involving Cow Karel and the mystery of the missing vegetables. Cow Karel and his companions go on an exploratory journey across different places on the farm to uncover clues about the missing vegetables. Prompts addressing the health benefits of vegetables, the importance of thorough chewing, a midway time cue, and a social moment encouraging children to share their favourite vegetables are seamlessly integrated into the narrative to support healthy eating behaviours.

The story is recorded using a microphone embedded in a laptop and was produced specifically for this prototype. It is narrated using two distinct non-professional voice actors, who each adopted different vocal styles to represent various characters, enhancing engagement and supporting character differentiation within the narrative. The sound file was post-processed using the software 'Audicity'. Some normalisation, other sound level adjustments, cuts, and additions such as sound effects were performed to make the quality of the storytelling audio as best as possible.

8.2.3 Hardware

For the prototype to work as intended, some electronics were required. A schematic overview of the complete hardware set-up of the prototype can be found in Figure 8.2. In Figure 8.3, a photo of the complete connected hardware of the prototype is shown. The specific electronic components that were used, will be discussed below.

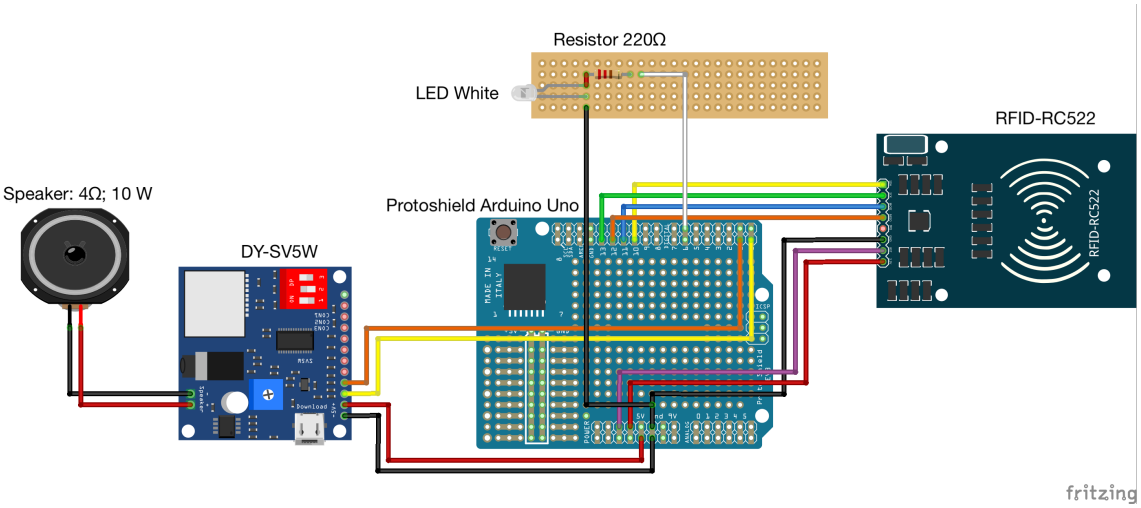

FIGURE 8.2: Schematic overview of the hardware

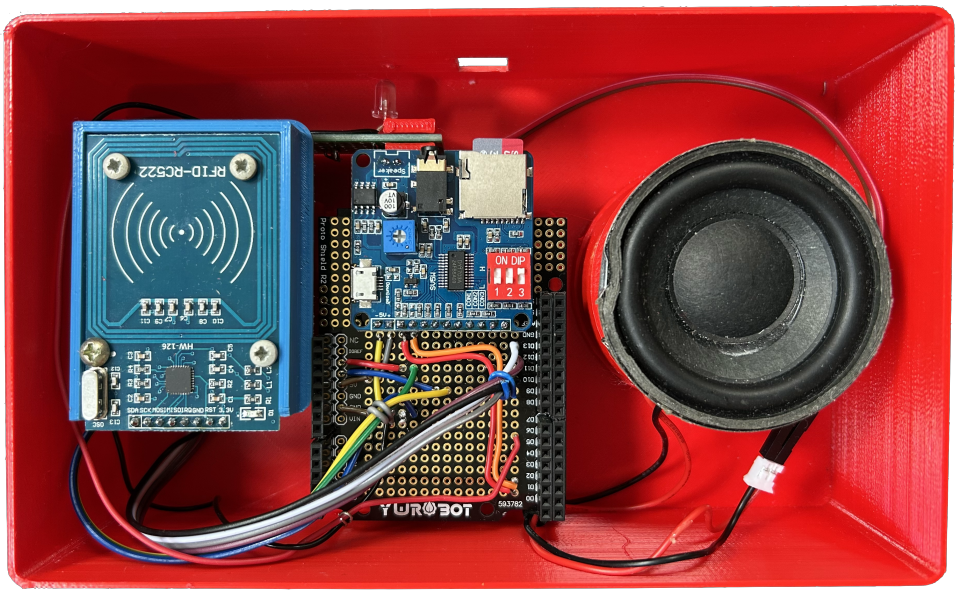

FIGURE 8.3: Picture of the hardware set-up

Arduino Uno

The Arduino Uno is used as microcontroller to operate all electric components of the circuit. It is an open-source microcontroller board based on the ATmega328P [130]. It can be seen as the brain of the prototype. Its accessibility and compatibility with various sensors made it a practical choice for this prototype development at this stage of the project.

RFID RC522 and RFID tags

The RC522 RFID module is a compact and efficient device that can be used to read and write RFID tags, making it suitable for interactive applications. The RC522 module operates at a voltage of 3.3V and communicates via a 13.56 MHz frequency. It is compatible with Arduino using an SPI interface. The RFID reader is implemented to be able to read

the different figures with integrated 13.56 MHz RFID tags. Each tag chip has its unique ID pre-programmed.

Speaker
The prototype includes a 4 Ohm, 10 Watt speaker that was repurposed from a previously dismantled device. The speaker delivers sufficient audio quality and volume for the intended storytelling function of this prototype.

MP3 Module
In order to make it easy to add sound playback functionality to the Arduino microcontroller, an MP3 module is used. The DY-SV5W is utilised as MP3 module for this prototype. DY-SV5W is an intelligent voice module that can be used to play sound/music. This module is equipped with an integrated audio amplifier, an SD card slot, audio jack, and can be controlled via UART or the GPIO pins.

For this prototype, it was preferred to control the audio using commands. Therefore, the audio was controlled via UART (Universal Asynchronous Receiver-Transmitter) used for serial communications over a computer. To be able to control audio via UART, the selectors on the red switch box on the module should be set to 1 = OFF, 2 = OFF, and 3 = ON. The audio files will be stored on a micro SD card and can be controlled with the use of different functions.

LED with resistor
For status indication purposes, an LED accompanied by a current-limiting resistor were integrated into the hardware setup. The LED remains continuously lit to signal that the system is powered and operational. After successful detection of a figure via RFID technology, the LED blinks several times, providing immediate visual feedback that an interaction has been registered.

Protoshield
A protoshield was used in combination with Arduino Uno to facilitate a more organised and reliable assembly of the electronic components. It allowed for custom soldering of connections, reducing the reliance on loose jumper wires and improving the stability and durability of the prototype during repeated handling and testing. The shield can be easily placed on and removed from the Arduino.

8.2.4 Software

The software for the tangible interface of the prototype was developed using the Arduino Integrated Development Environment (IDE), which utilises a simplified variant of the C++ programming language. A simplified flowchart of the developed Arduino software programme is shown in Figure 8.4 below.

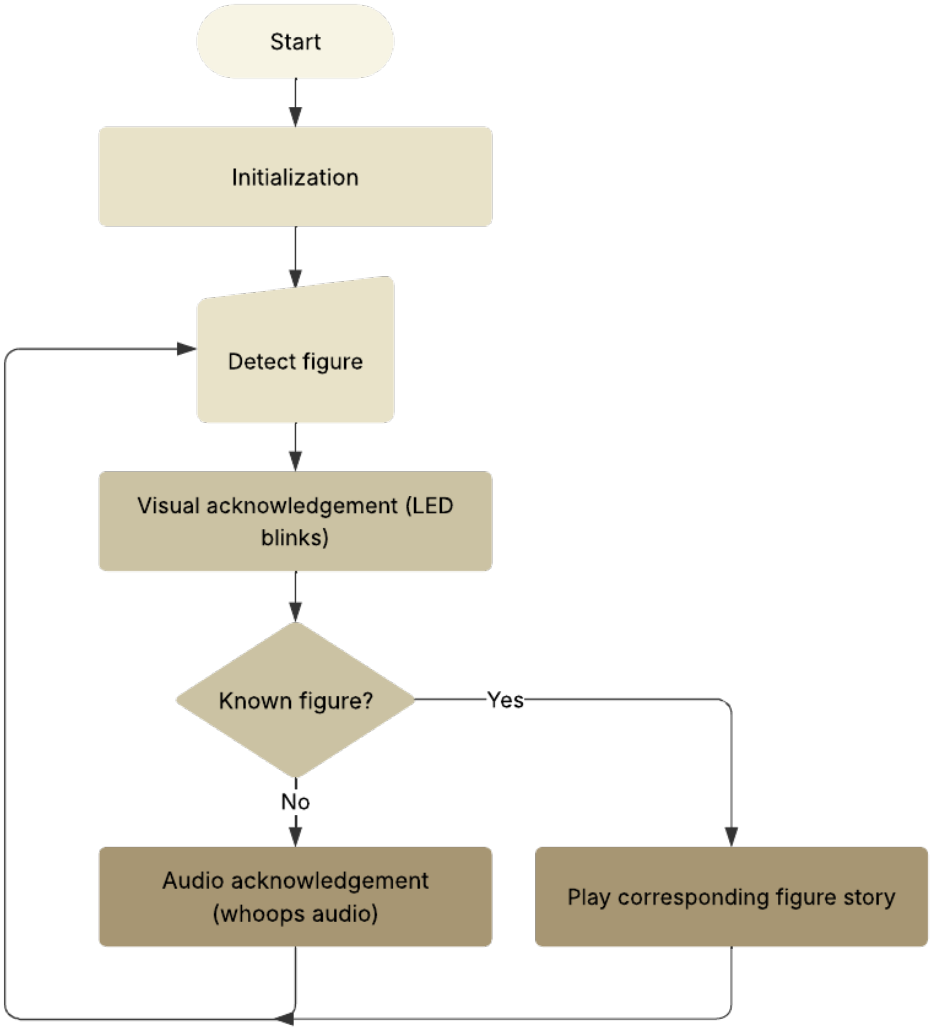

FIGURE 8.4: Simplified flowchart Arduino Software

The software first performs an initialisation where the required libraries are included and the different pins necessary on the Arduino board are defined. Each RFID tag has its own unique identifier (UID). The specific UIDs of the RFID tags are assigned to the figures in the initialisation as well. Furthermore, the player and its setup will be initialised for the audio part, the serial communication will be setup, the SPI and MFRC522 will be initialized for the RFID technology, and the digital LED pin will be initialized as an output.

After initialisation, the RFID is ready to read the RFID tags using the MFRC522 Arduino library and thus detect the figures. When an RFID tag is detected by the system, the LED will start blinking by setting the LED pin from high to low a few times repeatedly as a visual acknowledgement that something is detected. When the detected UID is unknown, an audio acknowledgement will be playing to convey the message. When a predefined UID is detected, the corresponding story associated with that figure is triggered and played. Using the function `player.playSpecifiedDevicePath(DY::Device::Sd, path)` as part of the DY Player library, a specific audio file can be triggered. After the story has ended

or if an unknown RFID tag was detected, the software returns to the beginning, and a new RFID tag can be detected again.

8.3 Graphical user interface

In addition to the tangible interface, the prototype also incorporates a graphical user interface (GUI), which serves as a complementary digital component to support and enhance the overall user experience. In this section, the developed graphical user interface will be presented by discussing the digital design and the coded software. A picture of the graphical user interface can be found in Figure 8.5 below.

FIGURE 8.5: Picture of graphical user interface

8.3.1 Digital design

The prototype graphical user interface consists of visual support for children and a teacher control interface and can be displayed on Digibord during lunch. Before the story starts, an empty farm scene is displayed without any elements of the story such as the animals or the farmer. During the introduction of the story, an image of the animal that tells the story will be displayed on the scene on the Digibord. When the real narrative begins, a static visual scene of the story is designed to support the narrative experience without distracting from the primary activity of eating. A digitally illustrated farm scene forms the central visual element, with the setting of the audio story and displaying the characters and events. The visual design was created through a combination of iterative input generated with ChatGPT and manual illustration using the Procreate application on an iPad.

This visual representation was created specifically to fit within the children's world of experience. The design uses warm and friendly tones to create a calm and cheerful mood. In addition, familiar and positive farm elements are included, which are often associated with farms by children and are featured in early childhood books and media regularly. The visual style is cartoon-like and simplified shapes with minimal details to make them easily recognisable and relatable for children. An open sky and green spaces are added elements to create a sense of calmness.

It also integrates a visual time indicator to help children track the remaining time of the lunch break. This is accomplished by starting with ten apples in the trees and over time the apples disappear. When there are no apples left, the time to eat is over. This visualisation of the time fits the target group. In addition, icons representing the rules during lunch break are presented in the top right corner. These icons were designed to be as simple as possible to be clear for children without too much distraction. These icons are visible during the entire lunch break, to make it easy for teachers to point out if children do not obey the rules and disturb the preferred atmosphere.

Furthermore, a small teacher support interface is integrated which is designed to be collapsible. It can be shown or hidden by clicking an arrow icon, allowing users to toggle its visibility as needed to maintain a clear and uncluttered display. The audio control functions and its representing icons are simple in use and intuitive just like other known digital audio control interactions like playing music in a mobile application. The colours were intentionally chosen to be less vibrant, as this helps minimising visual distraction for the children and ensures that the teacher support interface remains subtle and secondary to the main visual content.

8.3.2 Software

The graphical user interface of the prototype was developed using the software program Processing. This is a flexible software sketchbook and language based on Java [131]. Processing was selected for its ability to facilitate communication with the Arduino software program with the use of Serial communication, enabling synchronised behaviour between hardware and on-screen visuals and interactions. However, this is not yet accomplished at this stage of the prototype development. A simplified flowchart of the developed Processing software programme is shown in Figure 8.6 below.

The software first performs an initialisation where all required variables are defined, all the necessary images are loaded into the programme, and the initialisation of the screen and serial communication are performed. Once manual input is provided and story playback is started, the display can be updated. Within the interface, specific images appear or disappear based on predefined timestamps to support the structure of the lunch break and support narrative cues. The interface includes elements designed for teacher control, such as a pause and play button that switches based on if the audio is playing or not or the collapsible function of the control section. These functions are accomplished with the `mousePressed()` function in Processing. The loop in which the display will be updated will continue until the end of the story has reached or when a user interrupt is performed, causing the audio to be paused.

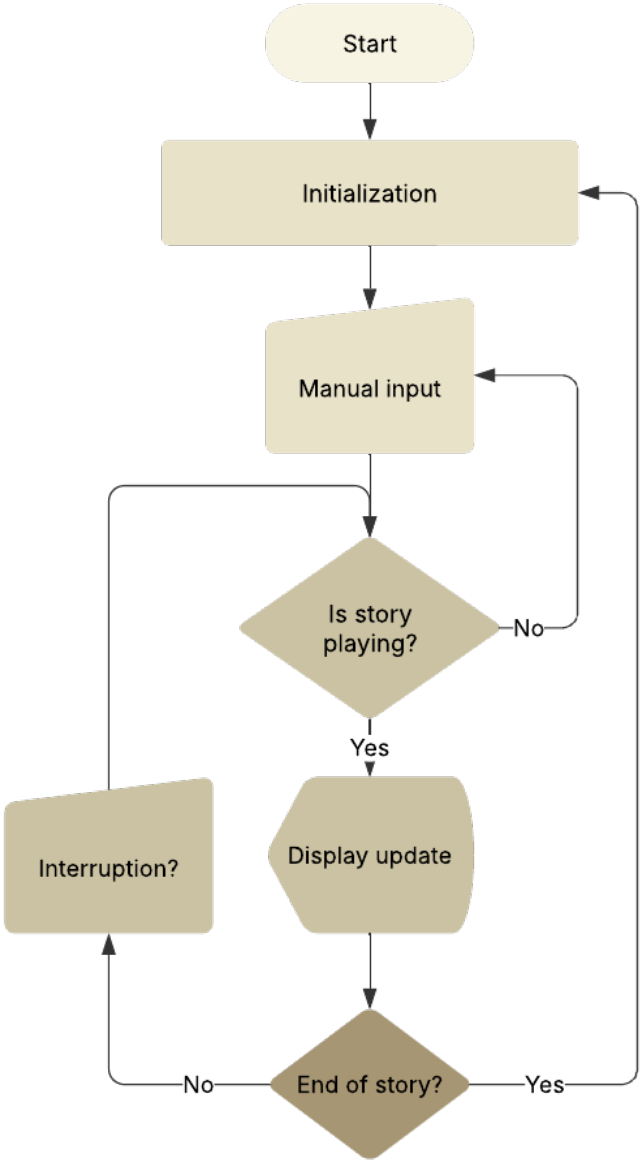

FIGURE 8.6: Simplified flowchart Processing Software

8.4 Limitations of the prototype

The current prototype had a few limitations. As previously mentioned, the prototype currently includes only a single fully developed story, which may not align perfectly with the cognitive or language levels of all children within the target age group. In addition, there is no working communication between the hardware of the tangible interface and the graphical user interface. Moreover, the hardware of the tangible interface will be powered using a cable connection with a laptop instead of working on its own using a battery. Furthermore, not all (control) functions as part of the graphical user interface are functional operating. Despite its limitations, the developed prototype will be functional enough to evaluate the core aspects of the concept as intended. However, some limitations may need to be taken into account when interpreting the outcomes of the evaluation.

Chapter 9

Evaluation

With the completion of the prototype, it is now possible to evaluate the concept. This chapter presents a three-part evaluation approach, including an exploratory user evaluation, teacher interviews, and a classroom observation to assess the potential of the concept. First, the objectives of the evaluation and the three separate tests are described. Subsequently, each evaluation test will be described and structured into methodology, results, and discussion and conclusion sections.

9.1 Introduction

The main objective of this evaluation is to explore the potential of the developed concept. By assessing how users interact with and respond to the prototype, the evaluation aims to explore how well the prototype aligns with the initial design objectives and to assess its effectiveness, relevance, and usability within the intended context. The findings help determine whether the concept aligns with the needs and expectations of the target users and provide directions for further refinement and development. To assess the potential of the concept, a series of three evaluation tests were conducted.

First, an exploratory user evaluation was conducted to gain a first impression of how children engage with the concept and interact with the narrative elements of the prototype. This helps in assessing the level of attention, enjoyment, and comprehension that the concept encourages. Secondly, several interviews were conducted with primary school teachers to gain insight into their perspectives on the relevance, practicality, and added value of the concept in an educational setting. Lastly, a classroom observation was carried out to gain insight into how the designed concept functions when introduced in a real classroom setting.

9.2 Exploratory User Evaluation

To investigate an initial impression of children's engagement and narrative interaction with the prototype, an exploratory user evaluation was performed. The following sections detail how the evaluation was conducted and discuss the corresponding results.

9.2.1 Methodology

In this section, the methodology of the exploratory user evaluation will be described, covering key aspects such as participant selection, ethical considerations, the test setting,

the evaluation procedure, and the data collection methods used.

Participants and Ethical Considerations

The exploratory user evaluation was conducted with two children, aged 3 and 4. The oldest is currently in grade 1, while the youngest (although not fitting the target group) will soon start primary school. The children were recruited through the daily supervisor of this project. Since the participants of this evaluation are minor and therefore not formally able to give consent themselves, a parent was asked to give permission. The information letter and consent form are provided in Appendix A. A parent of the children was present during the test, allowing the children feel safe and the evaluation to be stopped at any time if the child became uncomfortable.

Setting and procedure

The evaluation was conducted in a university meeting room. While this setting does not replicate the typical environment in which the intervention is intended to be used, it was selected due to logistical and organisational considerations. As this test was intended as an initial and exploratory evaluation, the fact that the setting did not replicate the typical environment was not considered an issue. In the meeting room a table was present on which the device and figures of the prototype were placed, and chairs were available for the children to sit on during the test. In addition, a large screen on the wall was present and used to present the web-application of the prototype. The children had their own lunch in their lunch box.

The session started with a short introduction to the activity with the created prototype. The children were instructed what they could expect during the test. Following these short preliminary explanations, the intervention started when one of the children was asked to place the cow figure on the device which initiated the intervention. During the intervention, the children listened to the story while eating their lunch. Afterwards, the children were asked a couple of questions. It was explained to the children that they could indicate at any time if a question was too difficult, if they had any questions, or if they did not wish to answer.

Data collection methods

For the exploratory user evaluation, a couple of data collection methods were utilised. During the intervention, observations were made using an observation table. Observations focused on aspects such as the children's reactions, attention span, (facial) expressions, and whether they continued eating during the evaluation. For instance, observations focused on questions such as: How do the children respond at the start? Do they continue eating calmly? Do they react to events in the story? And what happens during the social moment? The observation table with more details can be found in Appendix D.2.

After the interventions, the children were asked several questions about the intervention. These questions were aimed at gathering child feedback about the emotional involvement and interest, and story understanding. Examples of questions included: What did you think of the story? Would you be curious to hear the next adventure on Farmer Bram's farm—for example, a story about Suus the sheep? What did the farmer do with the vegetables? And what did you think of the illustration or the drawings? To support the

children in expressing their responses, a pictorial Likert scale featuring four smiley faces (ranging from very happy to unhappy) was used, providing a visual aid for understanding and communication. Both the questions asked after the intervention and the pictorial Likert scale can be found in Appendix D as well. The findings based on the observations and participants' responses to the questions are presented in the following section.

9.2.2 Results

Children's experiences

The children responded positively to the concept, as they indicated the story as (very) enjoyable. Their initial engagement was strong, with signs of excitement and curiosity as they recognised the animals. Facial expressions during the story such as smiling when the mice appeared and nodding when the story was at the apple tree, indicated some emotional involvement. The children expressed enthusiasm about the idea of more adventures on the farm and even asked about other stories from other animals again later that evening. The visualisation was also well-received; they commented that everything in the drawing was nice. It was observed that they regularly looked at the visualisation with focused attention. The use of different character voices in the story was perceived as funny and engaging. One child described it as "fun to listen to" and stated it was the same fun as watching television. However, there was some variation in engagement with regard to the social aspect, with a remark about alternating between listening and talking being redundant for the oldest.

Regarding focus, the children were regularly distracted by their surroundings or by items in their lunch box. For example, they were drawn to a sweet treat, started conversations with their parent (especially the youngest), or were distracted by objects around. In terms of comprehension, the children had difficulty recalling specific content from the story, such as what the hen "Kaatje" does to chew properly or what the farmer did with the vegetables. The oldest child did not find it difficult to listen to the story, while the youngest appeared to struggle more with maintaining attention.

Eating behaviour

Eating behaviour during the test was largely comparable to regular mealtime. Finishing the meal was reportedly just as challenging as usual. One child mentioned he forgot to drink. Despite that, both children ate consistently, with some initial hesitation. As the story progressed, they continued eating while occasionally glancing at the visualisation.

At the halfway point prompted by the story, the oldest child checked their lunch box, showing some responsiveness to the narrative cues. The social aspect of eating was slightly scary at first especially for the youngest, but improved slightly as the session continued. The mother took the initiative in encouraging the social context, and the overall duration was observed as appropriate for now with only two children. The youngest found the interactive experience enjoyable, while the oldest preferred to focus solely on listening.

One notable memory was that the oldest child could recall the apples from the story as time indicator after some reflection. However, overall, the time allocated for eating appeared slightly too short for finishing their lunch.

9.2.3 Discussion and conclusion

While the exploratory evaluation offered valuable insights, several limitations in the setup should be considered. First, the evaluation took place in a environment with a new person (the researcher) which may have influenced the children's behaviour and comfort level. Although the setting was chosen for practical reasons, it did not fully replicate the typical context in which the intervention would normally be applied. The presence of the mother during the session had both supportive and social benefits. Her involvement helped create a safe and positive atmosphere, which likely contributed to the children's willingness to participate and engage with the story. However, eating together with their mother was also enjoyable, and at times, they found it too tempting to start a conversation with her. This could have affected their attention to the story slightly. However, the youngest participant may have been slightly too young for this type of evaluation. Maintaining attention and fully understanding the content appeared to be more challenging for her.

Despite these limitations, the story struggled to fully hold the children's attention, and their ability to recall and understand its content was limited. The information density of the story might have been too high for the children's developmental stage, suggesting that future iterations could benefit from simplifying or segmenting the content more clearly. Nevertheless, the concept was received positively. The children enjoyed the story, the visualisation, and the character voices. Their curiosity about future adventures indicates potential for continued engagement and further development of the concept.

9.3 Teacher Perspectives on the Concept

To gain insight into the perspectives of teachers on the relevance, practicality, and added value of the concept in an educational setting, several teacher interviews are performed. The following sections detail how the evaluation was conducted and discuss the corresponding results.

9.3.1 Methodology

In this section, the methodology of the teacher evaluation interviews will be described, covering key aspects such as participant selection, ethical considerations, test setting, evaluation procedure, and data collection methods used.

Participants and Ethical Considerations

To gather information on the perspectives of teachers on the concept, three teachers from different Dutch primary schools were interviewed. Teachers who participated in the interviews all teach children in grade 1-4. These teachers took also part in earlier phases of the project and agreed to participate in the next phase. They were informed and provided consent using the information letter and consent form provided in Appendix A.

Setting and procedure

The interviews took place online and were conducted in a one-on-one format. With the participants' permission, the interviews were recorded. First, a short presentation about the concept was given to provide context and ensure the interviewee had a clear understanding of the concept and prototype and its intended purpose. Since the whole audio story takes almost 15 minutes, a few audio samples were played during the presentation,

to provide an impression of how certain elements were incorporated into the audio story. After the presentation, the teacher perspective on the concept was gathered by asking questions.

Data collection methods

Insights into the perspective of teachers on the concept were gathered through a semi-structured interview. A predefined set of open-ended questions guided the interviews. Topics like implementation in practice, support for teachers, contribution to a calm environment, and educational value are covered. Example questions included in the interview were: Can you see yourself using this in practice? Does the concept fit within the desired structure of the lunch break? Would the concept provide sufficient support in carrying out the lunch routine? And could this design contribute to creating more calm and structure during the lunch break? The complete list of questions is included in Appendix D.3. This semi-structured interview method was chosen to achieve both consistency between participants and flexibility in exploring relevant topics in more depth. After the interview data was collected and transcribed, thematic analysis was used to evaluate the data. After familiarising, the essential insights from the interviews were highlighted. Thereafter this highlighted data was grouped into relevant themes. Finally, the insights of the thematic analysis are reported in the Results section (Section 9.3.2 below).

9.3.2 Results

Teacher impressions

The initial reactions of the teachers were very positive. They described the concept as creative, playful, and refreshing. Teachers highlighted the importance of variation in the stories, noting that repeating the same story too often could reduce its impact, although they also acknowledged that young children often enjoy hearing the same stories multiple times, so some repetition could still be effective. Further expansion of the prototype with new stories, animals, and themes is thus recommended. The use of character figures was appreciated, especially for younger children, as one teacher mentioned it adds a playful and interactive element. The visual design and characters were described as attractive and child-friendly.

Practical implementation

Teachers generally saw themselves using the concept in practice, particularly because of its thematic approach and the embedded behavioural prompts. They expressed interest in trying it out and were curious about how children would respond. Most teachers believed the concept was suitable for children up to grade 3/4, especially if they were already introduced to it in earlier years.

From a practical standpoint, the teachers found the concept feasible to implement. The use of a Digibord was seen as a good fit, provided the audio volume was sufficient for classroom settings. Teachers agreed the concept could integrate well into the existing lunch routine, particularly because it encourages children to be quiet during the story and includes small learning moments. The duration of the story was functional for teachers as well, even if their lunch duration was a bit longer. Some adjustments were suggested, such as adding the ability to pause the story via the device, providing more story variation to suit different ages, and tailoring content to make it more challenging for older children.

Teacher support

Teachers felt that the concept could support them during the lunch break by allowing them to focus on other tasks while the children engaged with the story. One interviewee stated that she was hopeful the concept could support them, but found it difficult to say for sure without having experienced it herself. The supportive functions as part of the web-application were considered useful. The ability to pause or stop the audio was considered important due to the dynamic nature of lunch breaks, where unexpected interruptions (e.g., spills, accidents, or classroom visitors) are common.

Calm atmosphere

Most teachers believed the design could contribute to a calmer and more structured lunch environment. They appreciated the clear start by mentioning the rules and indicating that you should start eating. In addition, they valued the routine this could establish. "*Putting the device with figures in front of the class signals the start of the lunch routine*", as stated by a teacher. The use of audio was highlighted as particularly effective in reducing overstimulation compared to video content. Teachers noted that while a 15-minute audio story might require some training and adaptation for children, it could become a beneficial routine over time. The visual timer using apples was received positively. Teachers found this to be a gentle and playful way of communicating the remaining time without causing stress, unlike traditional countdown timers. The icons and visual cues were seen as helpful, especially for younger children.

Healthy eating behaviour

Teachers appreciated the explicit attention given to healthy eating behaviour within the concept. They noted that statements about chewing well, taking time to eat, and trying vegetables are valuable reminders. While one wondered whether children would continue eating during the story, others emphasised that such cues help create awareness and habits that are often overlooked in the classroom and at home. The brief interactive prompts encouraging healthy eating habits and social contact were seen as appropriate and supportive of healthy eating and communication.

Educational value

Although healthy eating behaviour is not typically a core curricular objective in primary education, teachers identified strong connections to language development because of the story aspect. They compared the use of the story with practices like reading aloud or playing educational videos, which are already considered part of instructional time due to language development. Some teachers argued if the concept would also touch on themes, which could strengthen its educational justification. Overall, teachers indicated that the intervention could be seen as valid use of time at school.

9.3.3 Discussion and conclusion

While the results of the teacher interviews provide valuable insights into the potential of the prototype, it is important to be careful with drawing conclusions from the results due to several limitations.

First, the feedback gathered is essentially hypothetical. Teachers were not evaluating the prototype based on actual classroom use but rather based on explanation, visual and audio impressions, and answers to their questions. As a result, their responses reflect expectations and assumptions rather than concrete experiences. Although these perspectives are useful for identifying potential benefits and concerns, they do not provide definitive evidence of the effectiveness of the prototype.

In addition, the number of participants in this evaluation was limited to three teachers. Although their feedback offered diverse and thoughtful reflections, the small sample size limits to what extent the results can be generalised.

Despite these limitations, the teachers' responses were generally positive. They saw potential in the concept and mentioned that it could support a calm lunch atmosphere, support the teacher, and promote a healthy eating behaviour. While their feedback was based on hypothetical use, their reactions suggest that the prototype could be a valuable addition to the classroom environment. Further evaluation involving a larger group of educators ideally in real-life classroom settings is needed to validate these initial insights.

9.4 Class observations

To gain insight into how the designed concept functions when introduced in a real classroom setting, a class observation is performed. The following sections explain how the evaluation was conducted and discuss the corresponding results. For this evaluation, the story was slightly adapted to decrease the information density, as was concluded from the exploratory user evaluation (see Section 9.2.3).

9.4.1 Methodology

For this evaluation, an observation of the typical course of a lunch break in practice and an observation of how the designed concept functions when introduced in a real classroom setting are performed. In this section, the methodology of the class observations will be described.

Participants and Ethical Considerations

The classroom observations were performed in one class. The teacher of the class was approached through the researcher's connections. The class consisted of grade 1/2 students and included 22 children. Since the participants of this evaluation are minor, they are not formally able to provide consent themselves. Therefore, the parent of the children were asked to give permission. They were informed through an information letter (see Appendix A) that was sent to them using the school's digital communication system. After they were informed about the study, they could give consent by signing a paper during the walk-in in the mornings when parents accompany their child into the classroom at the start of the day. Eventually, 20 permissions had been received. The children who did not have permission were allowed to join lunch and participate in the concept implementation, but they were not included in the study with observations and no questions were asked to them.

Setting and procedure

The observations took place during the lunch break in the classroom itself. One observation captured the teacher's regular lunch routine, while the other involved the use of the prototype described in Chapter 8. These observations took place on two consecutive days. On the first day, the observation focused on the regular lunch routine. The informed class followed their usual lunch break activities, while the researcher observed quietly from within the classroom. On the second day, at the start of the lunch break, the researcher briefly explained the concept and purpose of the prototype and gave instructions to initiate the intervention. During the intervention, the researcher observed quietly again from within the classroom. After the intervention, the children were asked a couple of questions about their experience with the concept. The questions were asked by the researcher to the entire class, with students indicating their willingness to respond by raising their hands.

Data collection methods

As mentioned before, insights into the classroom dynamics and experience were gathered mainly through observations. During both observation days, systematic observations were carried out using a tally sheet and a note-taking template. These are provided in Appendix D.4. These tools provided structure for documenting notable behaviours, reactions, and interactions of the children during the lunch routine. The observation focused on several predefined topics, such as engagement, calmness in the classroom, and responses to the story and healthy eating interventions. In addition, several short reflective questions were used during the observations, similar to the ones asked during the exploratory user evaluation (see Appendix D.2).

9.4.2 Results

Calm atmosphere

During the regular lunch routine, children started by placing their lunch boxes and cups on the table. Although singing a song marked the official start. During the first part of lunch, the teacher reads aloud to the class. Children were generally quite. During the storytelling, children began tidying up their lunch belongings when they were finished eating. After about twelve minutes, when the story was over, those who finished eating could read a book quietly, while others continued eating. The finished children took a book at the bookcase and seated where ever they wanted. When talking was permitted, reminders were regularly needed to keep it quiet. The variation in eating pace led to increased noise levels as the session progressed. As time passed, children still eating became a bit more restless, moving around and sometimes leaving their seats. At the end of the session, when the timer went off after 25 minutes, the children went outside noisily, with those unfinished leaving their lunch on the table to continue eating after playing outside.

During the lunch with the concept implemented, the first half of lunch period was generally quiet. Noise increased in the second half, especially from children who had finished eating. Some approached the device and figures as part of the prototype and sat near it. Similar to the regular routine, children began cleaning up early when they finished eating during the story. Moreover, there was little to no peer conversation during the story, quite similar to when the teacher told a story during the regular routine.

Eating behaviour

Children generally ate at a steady pace during the regular routine, though a few played with their food. There was no indication that children rushed through their meals. When the teacher was finished with reading aloud, she monitored children who were still eating and checked on their progress. However, it was unclear whether the teacher was fully aware if faster eaters who finished their meals, as the lunch boxes were already placed in the bag again, often during reading aloud of the teacher.

During the lunch where the concept was used, children appeared somewhat distracted of eating but generally remained calm and focused on the visualisation. Not all healthy eating prompts were absorbed. None of the children were observed to check their lunch boxes midway through the meal, when the story mentioned it. At the point in the intervention when the story addressed proper chewing (the suggestion to chew each bite while counting to ten) no noticeable change in behaviour was observed. While it can be argued that chewing behaviour such as chewing rate or frequency is inherently difficult to assess through external observation alone, no facial expressions or visible (finger) counting were observed that might have indicated a behavioural response. This suggests that either the message did not stand out enough or it failed to resonate with the children in that moment, resulting in limited observable impact. Nevertheless, the time indicator with the apples in the web-application were noticed and understood, as was mentioned by a few children afterwards. During the social aspect children discussed softly their favourite vegetables. However, an extra reminder was necessary. When the lunch break was finished, children even shared their favourite vegetables with the observer. Once the story's tune resumed, children's attention returned, and they became quieter again. The number of children finishing their meals was similar to the regular routine. The teacher questioned whether the level of distraction differed from that during video watching.

Children's experience

It was noted that the children responded positively to the concept story. They laughed at funny sound effects and interacted with prompts such as confirming if they were ready to start eating. The animal figures were particularly popular, children found it hard to resist touching them. Many expressed interest in hearing more stories featuring different animals. The children quickly recognised the animals as farm animals. Some were able to recall parts of the story when questioned. The visualisation component was engaging, with children recognising and naming many elements presented when asked about it.

9.4.3 Discussion and conclusion

While several aspects of the concept aligned with the intended goals, not all outcomes met expectations. For instance, the audio story and visualisation appeared to support a calm atmosphere and promoted engagement among many children, indicating that some of the design objectives were successfully achieved. Embedding eating interventions within the story appears to be a suitable approach to naturally and meaningfully promote healthy eating behaviours. However, based on the observations, the number and complexity of these interventions and the length of the story should be carefully aligned with the age and developmental level of the children. Too many or too complex interventions may disrupt the narrative flow and potentially reduce children's engagement or understanding. Furthermore, the timing and placement of social interaction in the current prototype seemed appropriate. The observations suggest that this component should not be extended much

further, in number and duration. Expanding or lengthening the social aspect too much could compromise the calm atmosphere, which is one of the core objectives of the concept.

These outcomes may, partly, be explained by limitations in the testing context. The observations were conducted within a single classroom, with a limited time frame and with a certain age as part of a larger target group. Moreover, the concept was only implemented once and the observations were only held once, while routine and healthy eating behaviours typically require repetition and reinforcement over a longer period of time to have a lasting impact. Furthermore, the habitual nature of the regular routine may also have influenced the way the lunch break went when the concept was applied. Another limitation was the volume of the audio story. Despite prior preparation, an unexpected technical complication led to suboptimal sound volume. Because of this, the sound turned out to be somewhat too soft for optimal engagement in the whole classroom.

It is difficult to draw definitive conclusions due to the number of limitations of this study. These constraints highlight the need for further research to explore the effects across varied classroom contexts, have repeated exposure, and longer implementation periods. This may yield different outcomes and should be considered in future research. Nevertheless, it was valuable and rewarding to test the concept in a real-life classroom environment, offering practical insights and a first indication of how the intervention might function in practice.

Chapter 10

Discussion

In this chapter the main findings, limitations, implications, and recommendations of this research will be discussed. The goal of this study was to answer the following defined research question:

"How can the organisation of the communal lunch in Dutch primary schools with a continuous schedule be improved to promote healthy eating behaviours among children while also fostering a more feasible and pleasant experience for teachers?"

10.1 Answering research question

Based on the preliminary research, a concept was developed, prototyped, and subsequently tested and evaluated. The findings suggest that the concept shows potential in improving the lunch break to promote healthy eating behaviours among children and fostering a more feasible and pleasant experience for teachers. This will be further explained in relation to the objectives and requirements outlined below.

10.1.1 Design objectives

The concept appears to have the potential to contribute to the design objectives defined in Chapter 5. The evaluations support the idea that the concept can help achieve these goals. However, some adjustments and iterations may be necessary before further investigation is conducted. In the following, each objective is discussed in more detail.

The first objective was to promote healthy eating behaviour among children. In the story as part of the concept, healthy eating interventions were incorporated. Teachers expressed these statements as valuable and supportive reminders that are often overlooked in the classroom and at home. Observations suggest that the number of elements related to healthy eating may have been too extensive and somewhat complex for the age group involved in the test, but could have more potential for the older children of the target group. So, the way to promote a healthy eating behaviour has potential, however further adjustments and research based on a longer-term study with repeated exposure and structured measurement moments is necessary.

Secondly, an objective was to support teachers in the many tasks they have to perform during the lunch break. From the evaluation it could be concluded that the concept showed potential in this area. Teachers have responded positively to it saying the concept allows

them to focus on other tasks while the children engaged with the story. The observation proved this as well, since the teacher could sit at her desk for a moment that was not observed in the regular routine.

Lastly, regarding the objective to foster a calm atmosphere, the following was evaluated. The intended goals appear to have been partially achieved, particularly during the first half of the intervention. However, in the second half, the effects were less evident. This may be due to various factors, such as the need for adjustments to the story or the impact of their regular routine, for example. Further research could explore the impact of a revised version of the story over a longer period of time to address the effects of the established routine. Additionally, teacher feedback indicate that clearly stating the rules in the story at the start along with corresponding visual icons as has been implemented in the concept, is considered helpful in fostering a calm atmosphere. At the same time, it seems beneficial to offer teachers the ability to customise which rules are presented, so they align with the classroom's existing rules and the age group of the children.

10.1.2 Requirements

Besides the design objectives, other requirements were also defined to ensure that it would be feasible for teachers, beneficial and suitable for children, and practical in terms of the implementation of the concept. These requirements help to further refine the potential of the concept and contribute to answering the central research question.

According to teachers, the concept could potentially be classified as instructional time, as it contributes to language development. However, it remains unclear to what extent the promotion of healthy eating behaviour aligns with certain educational lessons or themes. This raises the question: if it does not fall within the scope of these educational lessons, does that make it redundant, or does it rather address an area currently lacking attention within the school day? It can be argued that it might be the latter, as it is important to teach healthy eating behaviours to all children equally in an environment that models these practices, as suggested in literature as well [5, 6].

The use of visualisation could be worth considering, especially when aiming to move away from activities such as watching television. An important concern, is whether visual elements might distract too much from eating. Too much distraction from eating is not preferable. Evaluation results suggest that the visualisation may draw some attention away from the act of eating. At the same time, existing literature highlights its potential value in supporting story comprehension, particularly for younger children [126, 129]. In addition, the visual support is designed to be as static as possible to minimise the distraction. The observed distraction could be partly due to the novelty of the intervention, which reinforces the need for a longer-term study to assess its impact more accurately over time. Therefore, more research is needed to explore the effect of visualisation on both eating behaviour and story engagement. This could be investigated using for instance a between-subjects study design, in which two conditions (one with visualisation and one without) are tested and evaluated across two groups of participants.

The evaluation tests suggest that the concept is well suited for young children. Children appeared enthusiastic and engaged, and the thematic approach resonated well with them. Nonetheless, the teacher interviews and classroom observations clearly indicated that there are substantial differences in needs across the age groups as part of the target group. These

differences relate to the appropriate level and complexity of the story, the type and number of classroom rules, the suitable level and quantity of healthy eating interventions, and the thematic content itself. The range is considerable with a high speed of development, making it difficult to offer a one-size-fits-all version of the concept. Upon further reflection, a more methodological approach (which is commonly applied in educational practice) could be beneficial. For instance, a developmental learning trajectory (in Dutch often phrased as *"Doorlopende leerlijn"*) that gradually increases in complexity and adapts to the children's age may be a suitable way to align the concept accordingly. This idea is further supported by educational literature, which emphasises the benefits of a systematic progression and continuity in student development, the importance of differentiation, and the provision of practical support tools for teachers [132, 133, 134, 135].

Teachers were asked whether the concept would fit within their current classroom structure, and the responses were generally positive. Several teachers indicated that the approach aligns with their existing routines (often first quiet and thereafter room for talking) and could be implemented without major adjustments. In addition, the concept appears to align well with the typical 15 to 30 minute lunch break observed in many primary school classrooms, as the story component lasts just under 15 minutes. However, this raises questions about how to approach settings where the lunch break extends beyond that 15 minute duration. Should the story be lengthened? Should the social component be extended? Or is it even necessary to provide structured content for the remaining time? Extending the story may not be advisable, as attention spans of young children are limited and likely insufficient to maintain focus for a significantly longer narrative [136, 137]. It could be argued that extending the intervention may lead to increased screen time, which is not preferable at this time. Nevertheless, the static design of the visualisation is not intended for active or continuous viewing. Slightly extending the social interaction component could be a possibility, though it should not compromise the calm atmosphere that the intervention aims to foster and disturb the end of the story. Further research is needed to explore whether a structured addition is required for the remaining break time, or whether unstructured time may be sufficient.

10.2 Limitations and implications

While the findings provide valuable insights, it is important to acknowledge the limitations and implications of this study for future research and practical implementation. The evaluation tests had its limitations. The tests were conducted with a relatively small sample group of teachers and only one class with a specific age group. In addition, the feedback and perspectives gathered through evaluation interviews with teachers were essentially hypothetical, as teachers were evaluating the prototype based on explanation rather than actual classroom use. However, this limitation was reduced as much as possible by providing a prepared explanation, visual and auditory impressions, and the opportunity to ask questions. Lastly, observations in the class were only performed once with the implementation of the concept. This resulted in a relatively short-term study, which limited the ability to assess long-term outcomes (which are for some aspects such as healthy eating behaviour necessary) and to minimise the influence of novelty and other short-term effects.

Furthermore, reflecting on the prototype and concept, a few considerations emerged. In hindsight, involving experts in a co-design process during the ideation and prototyping phases might have added additional value. Especially for the development of the narra-

tive, collaborating with professionals (such as educators, child psychologists, or storytelling experts) could have helped to ensure the content was even better tailored to the target age group and educational goals. This collaborative approach might be a valuable consideration for future iterations of the concept. These kind of iterations on the prototype are eventually necessary. However, it was decided that this would be a step to take after evaluating the potential of the concept and prototype, before moving on to further iterations. This approach allowed for an initial exploration after which more targeted improvements and expert involvement can be considered in the next phase before further research will be conducted.

Looking back, observing the lunch situation during the initial context phase could have been a valuable addition to this research. The survey and teacher interviews already provided a solid and detailed understanding of current practices and challenges. However, a real-life observation would have completed this picture. During the analysis of the evaluation interviews, no significant new themes emerged, suggesting some degree of data saturation was reached. This strengthens the reliability of the insights obtained, although classroom observations could still have provided additional value. Such observations can still be conducted in future stages to support further iterations and refinements of the concept and prototype.

At the start of the project, during the context phase, it was chosen to focus on teacher practices. This decision was based on the perceived potential within this domain to contribute most effectively to the overarching goal of this research. However, it may be valuable to also consider other influencing factors (as described in Chapter 2 as well) in future work. For instance, exploring aspects at the policy level or more personal, individual-level factors could reveal additional opportunities for improvement and impact.

10.3 Further development

As touched upon in sections above, a couple of aspects need some further development. To get the prototype fully working as intended, the communication between the hardware and the visualisation must function, and the device's volume needs improvement as was experienced in the real-life setting during the observation. In addition, the design of the device itself could be further enhanced to increase its appeal to children. For example, shaping the device as a half-open farm could make it more engaging and visually inviting for children.

To further strengthen the prototype, the content (in particularly the story) can be enhanced and refined. This, combined with a methodical approach featuring a continuous learning pathway (in Dutch, *doorlopende leerlijn*), makes the product even more effective and adaptable to the developmental needs of children. The further refinement of the prototype would be best carried out collaboratively with experts in education, healthy eating behaviour, and storytelling fields, to enhance the quality and effectiveness of the narrative with a methodical approach.

In addition, more flexibility should be added enabling teachers to customise aspects according to their own and their class's preferences. For example, the ability to select which rules you want to apply in your class. Lastly, the prototype needs extension with more stories, characters, and themes, all tailored to suit the specific age group of the class.

10.4 Future research

As can be concluded, this research has identified multiple areas for future research. The added value of visualisation, for example, remains uncertain. Observations suggest that it may demand slightly too much attention from the children, potentially causing distraction from eating. However, the visualisation can support story comprehension, which is beneficial according to literature [126, 129]. It is possible that the observed distraction is related to the novelty of the visualisation. Further research is needed to clarify its true impact.

In addition, the impact of the healthy eating interventions were not yet measured in the evaluation phase to determine whether children's eating behaviour had improved. Assessing such behavioural changes would require a longer-term study with repeated exposure and structured measurement moments. Future research should examine the improvement on the children's eating behaviour. How to measure this, should be thoroughly researched. Literature offers several suggestions for assessing children's learning and behaviour related to food, such as using knowledge tests, self- or parent-reported questionnaires, direct behavioural observations, liking ratings, and interviews [138]. For mindful eating specifically, Hart et al. [139] developed a mindful eating questionnaire for children that could potentially be used. However, it is important to carefully consider which methods are most appropriate and valid for the specific context and age group. Further investigation is needed to identify the best ways and to perform the test to accurately evaluate the impact of the healthy eating aspects implemented in the concept.

Some of the requirements defined in the early stages of the project have not yet been evaluated. These requirements fell outside the scope of the current study due to limitations in time and focus. These requirements focussed on affordability, required trainings, and sustainability over time. Since the focus was on exploring the concept's potential, these requirements were not included in the evaluation. However, they remain relevant for the further development and implementation of the concept. Future research or design iterations should consider including these aspects to ensure a more comprehensive evaluation.

Furthermore, it is advised to change the methodology of future research. With a long-term study with a larger sample size, the generalisability of the insights increase. An example of a research question for a longer-term study could be: How effective is the intervention in promoting healthy eating behaviour during lunch among young children over an extended period and across multiple classroom settings? Especially given the variation in how schools structure their lunch breaks and the fact that the impact of the concept can best be assessed over time once it has been repeated and the effects of novelty have diminished. It is therefore recommended that future research includes a broader range of teachers and classes from different schools to further explore over a longer period of time.

With appropriate adjustments, the introduction of flexibility, and the expansion of stories and themes, further research can explore whether the content aligns better with the age and developmental level of the children. Moreover, to further improve the concept, it would be valuable to investigate whether implementing a structured methodology, such as a continuous learning trajectory (*doorlopende leerlijn*) which is commonly used in educa-

tion, would be effective. This approach could support a gradual build-up of complexity and ensure better alignment with educational practices. Collaborating with experts in education, child development, and curriculum design is recommended as future research to determine how such a methodical structure could be integrated into the concept.

Chapter 11

Conclusion

A healthy eating behaviour is of high importance to reduce the risk of overweight and its health consequences which is an increasing problem. Childhood is a critical period in the development of obesity, therefore, it is crucial that children at a young age become aware of and are encouraged to adopt healthy eating behaviours. This is particularly effective in environments that model these behaviours and are accessible to children across all risk groups, such as during the communal lunch break in primary schools. Therefore, the aim of this research was to explore how the organisation of the communal lunch in Dutch primary schools that follow a continuous schedule can be enhanced to promote healthy eating behaviours among children while also fostering a more feasible and pleasant experience for teachers.

To address this main research question, several sub-questions were formulated that formed the basis for the main findings of this research. First, the current lunch break situation was examined. It proved to be a dynamic and complex moment influenced by various factors operating at different levels, including the school, classroom, and individual level factors. Among these, teacher practices (such as implemented activities and rules) emerged as the most promising opportunity to improve the implementation of the lunch break and to promote healthy eating behaviours among young children. These teacher practices were further explored through conversations with several teachers. No practical solutions existed that align with the school lunch setting. Further findings highlight several technologies, interventions, and strategies from different domains offering inspiration for the ideation phase.

All insights gathered during the context phase were translated into a set of design objectives that the concept should fulfil in order to meet the goal of this study. The three main goals that were emerged are that the concept must foster a calm atmosphere, promote healthy eating behaviour among children, and support teachers during lunch. Based on these goals and additional requirements, a concept was developed, elaborated, and subsequently prototyped. This concept consists of an interactive device with physical figures that represent different characters, using a thematic approach. When a figure is placed on the device, it activates an audio-based storytelling experience that guides children through lunch with healthy eating aspects integrated, while a digital web application on the digibord provides visual support for children and supervision support for teachers. The concept and its prototype were evaluated through a series of tests. The evaluation indicates that the concept demonstrates potential to meet the identified objectives, despite limitations such as a small participant group, short-term testing period, and the hypothetical nature

of the teacher-based assessments.

Thus, with the designed concept, the organisation of the communal lunch in Dutch primary schools with a continuous schedule can potentially be improved to promote healthy eating behaviours among children while also fostering a more feasible and pleasant experience for teachers. While promising, the prototype still requires further development, particularly in improving the content with input from experts in relevant fields, applying a structured educational approach such as a developmental learning trajectory, and incorporating flexibility to better align with the needs of both children and teachers. Subsequent research can then explore whether these refinements strengthen the concept in achieving its intended objectives. This should include more robust evaluation methods, as well as a long-term study with a larger sample size. In conclusion, this study was a first step in demonstrating the concept's potential in improving the lunch break on primary schools, however further development and research are essential to fully assess its impact.

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Appendix A

Ethical considerations

In this appendix, several different ethical considerations used during this research are shown.

A.1 Ethical documents

For a study with humans, it is of importance to make sure participants know their rights and approve they want to voluntary participate in the study. These documents have been approved by the Ethics Committee of Computer and Information Science of the University of Twente, with reference numbers 240717 and 250807.

Information letters were written to provide an overview of the information participants need to know about the research, the process of the study, their rights and what will happen to their data. All participants were asked to read to information letter. Besides the information letters, consent forms were drawn up as well. This is a document that seeks permission from participants of the study to proceed, which was asked to all participants to sign before continuing to the study itself.

Informatie brief voor het interview met leerkracht basisonderwijs over de organisatie van de gezamenlijke lunch op Nederlandse basisscholen

Dit document biedt informatie over het doel van dit onderzoek, wat er tijdens het interview zal gebeuren en contactgegevens voor eventuele vragen.

DOEL VAN DIT ONDERZOEK
Voor mijn masterthesis aan de Universiteit Twente wil ik de inhoud en organisatie van de lunch op Nederlandse basisscholen verkennen. We merken dat steeds meer scholen een continurooster (of vijf-gelijke-dagenmodel) hanteren, waarbij alle leerlingen hun lunch op school eten. Deze ontwikkeling zorgt voor een andere dynamiek tijdens de lunchpauze, zowel voor de leerlingen als de leerkrachten. Ons doel is om mogelijkheden te identificeren om de lunchpauze gemakkelijker, beter beheersbaar en gezonder te maken voor iedereen.

INTERVIEW
Om een beter inzicht te krijgen in wat er tijdens de lunch in de klas gebeurt, welke uitdagingen een leerkracht ervaart en hoe een leerkracht het beste ondersteund kan worden, zal er een interview worden gehouden met leerkrachten in het basisonderwijs. Het interview wordt opgenomen en vervolgens uitgetypt. Zodra de transcriptie voltooid is, wordt de opname veilig verwijderd.

Dit onderzoeksproject is beoordeeld door de Ethische Commissie 'Information and Computer Science'. U kunt op elk moment stoppen met het onderzoek door aan te geven dat u wilt stoppen, waarna het interview onmiddellijk wordt beëindigd. U hoeft geen reden op te geven waarom u wilt stoppen, en er zijn geen gevolgen voor u als u besluit te stoppen.

GEGEVENS
Persoonlijke gegevens zoals uw naam, beroep en handtekening worden tijdens het onderzoek verzameld. De handtekening wordt alleen gebruikt voor het toestemmingsformulier. Alle andere gegevens worden volledig anoniem behandeld. De tijdens het onderzoek verzamelde gegevens blijven vertrouwelijk.

U ontvangt een kopie van het toestemmingsformulier.

CONTACTGEGEVENS
Als u vragen heeft over dit onderzoek of meer informatie wilt over het project, kunt u contact opnemen met de onderzoeker:

Onderzoeker: Lotte Lukassen
E-mailadres: c.m.a.lukassen@student.utwente.nl

Of met de dagelijkse begeleider van dit project:

Begeleider: Juliet Haarman
E-mailadres: j.a.m.haarman@utwente.nl

Als u vragen heeft over uw rechten als onderzoeksdeelnemer, of informatie wilt verkrijgen, vragen wilt stellen, of eventuele zorgen over dit onderzoek met iemand anders dan de onderzoeker(s) wilt bespreken, neem dan contact op met de secretaris van de Ethische Commissie Information & Computer Science:

E-mailaddres: ethicscommittee-CIS@utwente.nl

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FIGURE A.1: Information letter teacher interviews

Toestemmingsformulier voor interview over de gezamenlijke lunch op Nederlandse basisscholen

U ZAL EEN KOPIE VAN DIT TOESTEMMINGSFORMULIER ONTVANGEN

Vink de juiste vakjes aan	Yes	No
Deelnemen aan de studie		
Ik heb de studie-informatie van 20-01-2025 gelezen en begrepen, of het is mij voorgelezen. Ik heb vragen kunnen stellen over de studie en mijn vragen zijn naar mijn tevredenheid beantwoord.	☐	☐
Ik stem er vrijwillig mee in om deel te nemen aan dit onderzoek en begrijp dat ik kan weigeren vragen te beantwoorden en dat ik me op elk moment kan terugtrekken uit het onderzoek, zonder een reden op te geven.	☐	☐
Ik begrijp dat het deelnemen aan de studie een audio-opgenomen interview inhoudt dat zal worden getranscribeerd als tekst, waarna de opname zal worden verwijderd.	☐	☐
Gebruik van de informatie in de studie		
Ik begrijp dat de informatie die ik verstrek, zal worden gebruikt voor een rapport, presentatie en publicaties.	☐	☐
Ik begrijp dat persoonlijke informatie die over mij wordt verzameld en die mij kan identificeren, zoals mijn naam en mijn beroep, niet buiten het studieteam zal worden gedeeld.	☐	☐
Ik ga ermee akkoord dat mijn informatie kan worden geciteerd in onderzoeksresultaten.	☐	☐
Ik ga akkoord met het maken van een audio-opname.	☐	☐
Toekomstig gebruik en hergebruik van de informatie door anderen		
Ik geef toestemming om de audio-opname die ik verstrek als transcriptie te archiveren, zodat deze kan worden gebruikt voor toekomstig onderzoek en leren.	☐	☐
Ik ga ermee akkoord dat mijn informatie kan worden gedeeld met andere onderzoekers voor toekomstige onderzoeken die vergelijkbaar zijn met deze studie. De informatie die met andere onderzoekers wordt gedeeld, bevat geen informatie die mij direct kan identificeren. Onderzoekers zullen geen contact met mij opnemen voor aanvullende toestemming om deze informatie te gebruiken.	☐	☐
Ik geef de onderzoekers toestemming om mijn contactgegevens te bewaren en contact met mij op te nemen voor toekomstige onderzoeksprojecten.	☐	☐

Handtekeningen

_____	_____	_____
Naam van deelnemer	Handtekening	Datum

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FIGURE A.2: Consent form teacher interviews page 1

Ik heb het informatieblad aan de deelnemer overhandigd en ervoor gezorgd, voor zover mogelijk, dat de deelnemer begrijpt waarmee hij vrijwillig instemt.

_____	_____	_____
Naam onderzoeker	Handtekening	Datum

Onderzoek contactgegevens voor meer informatie:

Lotte Lukassen
c.m.a.lukassen@student.utwente.nl

Contactgegevens voor vragen over uw rechten als onderzoeksdeelnemer

Als u vragen heeft over uw rechten als onderzoeksdeelnemer, of als u informatie wilt verkrijgen, vragen wilt stellen of zorgen over deze studie wilt bespreken met iemand anders dan de onderzoeker(s), neem dan contact op met de secretaris van de Ethische Commissie Information & Computer Science: ethicscommittee-CIS@utwente.nl

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FIGURE A.3: Consent form teacher interviews page 2

Information letter child-focussed evaluation concept school lunches

This document provides information about the goal of this research, what will happen during the interview and some contact information for further questions.

GOAL OF THIS RESEARCH
As part of my master thesis at the University of Twente, I aim to explore how the current lunch break at Dutch primary schools could be improved, as observations have shown that the current situation is not ideal. This evaluation focuses on gathering feedback on the concept that emerged from my research, with specific attention to the storytelling element and how it relates to the children's experience and perception.

EVALUATION EXPERIMENT
In order to gather feedback on the concept, an evaluation experiment will be held. Data will be gathered through observation.

This research project has been reviewed by the Ethics Committee Information and Computer Science. You can withdrawal from the study at any time by stating you want to stop and the interview will stop immediately. You do not have to give a reason why you want to stop, and there are no consequences for you if you want to stop.

DATA
Personal information like your name, and your signature will be collected during the study. The name and signature will only be used for the consent form. All the other data is completely anonymous. Data collected during the research will maintain confidential.

You will receive a copy of the consent form.

CONTACT INFORMATION
If you have any questions regarding this study or if you want more information about the project, you can contact the researcher:

Researcher: Lotte Lukassen
E-mail adress: c.m.a.lukassen@student.utwente.nl

Or the daily supervisor of this project:

Supervisor: Juliet Haarman
E-mail adress: j.a.m.haarman@utwente.nl

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science:

E-mail address: ethicscommittee-CIS@utwente.nl

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FIGURE A.4: Information letter exploratory user evaluation

Consent form child-focussed evaluation concept school lunches

WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I have read and understood the study information dated 13-04-2025, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
I understand that taking part in the study involves an video-recorded evaluation experiment and some questions afterwards.	☐	☐
Use of the information in the study		
I understand that information I provide will be used for a report, presentation and publications.	☐	☐
I understand that personal information collected about my children that can identify them, such as e.g. their name, will not be shared beyond the study team.	☐	☐
I agree that information my children give can be quoted in research outputs.	☐	☐
Future use and reuse of the information by others		
I give permission for the observations to be archived as transcription so it can be used for future research and learning.	☐	☐
I agree that information my children provide may be shared with other researchers for future research studies that are similar to this study. The information shared with other researchers will not include any information that can directly identify me. Researchers will not contact me for additional permission to use this information.	☐	☐

Signatures

_____	_____	_____
Name of participant	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name	Signature	Date

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FIGURE A.5: Consent form exploratory user evaluation page 1

Study contact details for further information:

Lotte Lukassen
c.m.a.lukassen@student.utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science: ethicscommittee-CIS@utwente.nl

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FIGURE A.6: Consent form exploratory user evaluation page 2

Informatie brief voor leerkracht interview: evaluatie concept school lunches

Dit document biedt informatie over het doel van dit onderzoek, wat er tijdens het interview zal gebeuren en contactgegevens voor eventuele vragen.

DOEL VAN DIT ONDERZOEK
Als onderdeel van mijn masterthesis aan de Universiteit Twente richt ik mij op het verbeteren van de huidige lunchpauze op Nederlandse basisscholen, aangezien uit onderzoek is gebleken dat de huidige situatie niet ideaal is. Deze evaluatie is bedoeld om feedback te verzamelen op het concept dat uit mijn onderzoek is voortgekomen.

INTERVIEW
Om feedback op het concept te verzamelen, zal er een interview worden gehouden met leerkrachten in het basisonderwijs. Het interview wordt opgenomen en vervolgens uitgetypt. Zodra de transcriptie voltooid is, wordt de opname veilig verwijderd.

Dit onderzoeksproject is beoordeeld door de Ethische Commissie 'Information and Computer Science'. U kunt op elk moment stoppen met het onderzoek door aan te geven dat u wilt stoppen, waarna het interview onmiddellijk wordt beëindigd. U hoeft geen reden op te geven waarom u wilt stoppen, en er zijn geen gevolgen voor u als u besluit te stoppen.

GEGEVENS
Persoonlijke gegevens zoals uw naam, beroep en handtekening worden tijdens het onderzoek verzameld. De handtekening wordt alleen gebruikt voor het toestemmingsformulier. Alle andere gegevens worden volledig anoniem behandeld. De tijdens het onderzoek verzamelde gegevens blijven vertrouwelijk.

U ontvangt een kopie van het toestemmingsformulier.

CONTACTGEGEVENS
Als u vragen heeft over dit onderzoek of meer informatie wilt over het project, kunt u contact opnemen met de onderzoeker:

Onderzoeker: Lotte Lukassen
E-mailadres: c.m.a.lukassen@student.utwente.nl

Of met de dagelijkse begeleider van dit project:

Begeleider: Juliet Haarman
E-mailadres: j.a.m.haarman@utwente.nl

Als u vragen heeft over uw rechten als onderzoeksdeelnemer, of informatie wilt verkrijgen, vragen wilt stellen, of eventuele zorgen over dit onderzoek met iemand anders dan de onderzoeker(s) wilt bespreken, neem dan contact op met de secretaris van de Ethische Commissie Information & Computer Science:

E-mailaddres: ethicscommittee-CIS@utwente.nl

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FIGURE A.7: Information letter class observation for teacher

Toestemmingsformulier voor interview over de gezamenlijke lunch op Nederlandse basisscholen

U ZAL EEN KOPIE VAN DIT TOESTEMMINGSFORMULIER ONTVANGEN

Vink de juiste vakjes aan	**Yes**	**No**
Deelnemen aan de studie		
Ik heb de studie-informatie van 13-04-2025 gelezen en begrepen, of het is mij voorgelezen. Ik heb vragen kunnen stellen over de studie en mijn vragen zijn naar mijn tevredenheid beantwoord.	☐	☐
Ik stem er vrijwillig mee in om deel te nemen aan dit onderzoek en begrijp dat ik kan weigeren vragen te beantwoorden en dat ik me op elk moment kan terugtrekken uit het onderzoek, zonder een reden op te geven.	☐	☐
Ik begrijp dat het deelnemen aan de studie een audio-opgenomen interview inhoudt dat zal worden getranscribeerd als tekst, waarna de opname zal worden verwijderd.	☐	☐
Gebruik van de informatie in de studie		
Ik begrijp dat de informatie die ik verstrek, zal worden gebruikt voor een rapport, presentatie en publicaties.	☐	☐
Ik begrijp dat persoonlijke informatie die over mij wordt verzameld en die mij kan identificeren, zoals mijn naam en mijn beroep, niet buiten het studieteam zal worden gedeeld.	☐	☐
Ik ga ermee akkoord dat mijn informatie kan worden geciteerd in onderzoeksresultaten.	☐	☐
Ik ga akkoord met het maken van een audio-opname.	☐	☐
Toekomstig gebruik en hergebruik van de informatie door anderen		
Ik geef toestemming om de audio-opname die ik verstrek als transcriptie te archiveren, zodat deze kan worden gebruikt voor toekomstig onderzoek en leren.	☐	☐
Ik ga ermee akkoord dat mijn informatie kan worden gedeeld met andere onderzoekers voor toekomstige onderzoeken die vergelijkbaar zijn met deze studie. De informatie die met andere onderzoekers wordt gedeeld, bevat geen informatie die mij direct kan identificeren. Onderzoekers zullen geen contact met mij opnemen voor aanvullende toestemming om deze informatie te gebruiken.	☐	☐
Ik geef de onderzoekers toestemming om mijn contactgegevens te bewaren en contact met mij op te nemen voor toekomstige onderzoeksprojecten.	☐	☐

Handtekeningen

_____	_____	_____
Naam van deelnemer	Handtekening	Datum

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FIGURE A.8: Consent form class observation for teacher page 1

Ik heb het informatieblad aan de deelnemer overhandigd en ervoor gezorgd, voor zover mogelijk, dat de deelnemer begrijpt waarmee hij vrijwillig instemt.

_____	_____	_____
Naam onderzoeker	Handtekening	Datum

Onderzoek contactgegevens voor meer informatie:

Lotte Lukassen
c.m.a.lukassen@student.utwente.nl

Contactgegevens voor vragen over uw rechten als onderzoeksdeelnemer

Als u vragen heeft over uw rechten als onderzoeksdeelnemer, of als u informatie wilt verkrijgen, vragen wilt stellen of zorgen over deze studie wilt bespreken met iemand anders dan de onderzoeker(s), neem dan contact op met de secretaris van de Ethische Commissie Information & Computer Science: ethicscommittee-CIS@utwente.nl

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FIGURE A.9: Consent form class observation for teacher page 2

UNIVERSITY
OF TWENTE.

Beste ouders/verzorgers,

Hallo! Mijn naam is Lotte en ik ben student aan de Universiteit Twente.
Ik doe momenteel onderzoek naar de invulling van de gezamenlijke lunchpauze op basisscholen voor zowel leerlingen als de leerkracht.

Binnenkort (donderdag 15 en vrijdag 16 mei) kom ik in de klas van uw kind om een nieuwe invulling van de lunchpauze, wat ik zelf ontworpen heb, uit te proberen.
Het is een leuke, ontspannen activiteit die tijdens het eten en drinken in de hele groep uitgevoerd wordt en waarbij de kinderen onder andere luisteren naar een verhaal.

Tijdens deze lunchpauze zal ik observaties uitvoeren. Deze observaties zijn volledig anoniem en richten zich op het gedrag van de kinderen tijdens de activiteit (bijvoorbeeld: eten de kinderen gewoon door, worden ze afgeleid, laat het luisteren naar het verhaal een zichtbare gedragsverandering zien?). Er worden geen namen genoteerd en de gegevens zijn niet te herleiden tot uw kind.

Voor mijn onderzoek zou het heel waardevol zijn om de anonieme observatiegegevens te mogen gebruiken. Daarom zou ik het erg op prijs stellen uw toestemming te ontvangen. U kunt dit doen door tijdens de inloop op 12 en 13 mei uw handtekening te zetten op de toestemmingslijst die klaar ligt in de klas.

Heeft u vragen over het onderzoek of werkwijze, dan kunt u met mij contact opnemen via dit mailadres: c.m.a.lukassen@student.utwente.nl

Alvast hartelijk dank voor uw medewerking.

Met vriendelijke groeten,
Lotte Lukassen
Universiteit Twente

FIGURE A.10: Information letter class observation for parents

A.2 AI discloser

The AI tool ChatGPT has been used occasionally during the thesis process. It has been used in the following ways:

- Generate a first version of the story script based on some predefined story aspects.
- Generate a first version of the visual design for the graphical user interface of the prototype that was adjusted with manual illustration using the Procreate application on an iPad.
- Getting synonyms for formal word choices.
- Help with rephrasing specific sentences when I was struggling.

All the suggestions of AI have been carefully examined and usually adapted to fit my writing style.

Appendix B

List of ideas

B.1 Idea generation

1. Spoken mindful eating meditation animal/mascot/plant
2. Ring with LEDs as a countdown mechanism
3. Soothing sound or calm music when they eat quietly
4. Variable based on how long there is a break or the age group or something
5. "Reward" based on sound measurement
6. (Familiar) podcast
7. Learning about food in game form
8. Scavenger hunt about healthy food
9. LED panel that indicates sound level
10. Sensory toys
11. Assignments booklet about food with e.g. a drawing assignment
12. Londji calm stamp set
13. Meditation guidance spoken by familiar voice(s) that appeal to children
14. Device that can convey tactile calm breathing
15. Smart lunch box
16. Interactive art (LED screen or on digital board)
17. Pre-recorded story that asks mindful eating questions in between
18. Cuddly object
19. Device with buttons where children can indicate mood etc. based on what they eat or how they experience the noise level.
20. A type of dice/object with technology in it and then based on which side it is on, questions can be asked to the children

21. A type of disc/marble that you have to put somewhere as a kind of answer
22. A type of slider to indicate how full you are etc.
23. A robot that stands in front of the class
24. A wearable device that augments users to hear through skin in the form of vibrations
25. Blocks with food icons with which they can make a construction of what is in their lunch box with information that something can be said about
26. Put food cubes on a plate/in a drum
27. A type of Beebot that takes steps forward based on what is eaten (relative to the time, maybe)
28. Interactive podcast that asks questions based on answers
    (a) Speech recognition
    (b) A majority of tokens with answers
29. Questions etc. that encourage the social side of lunch
30. Using image processing to show children what they are eating, where it comes from etc.
31. Children all wear their own headphones with story
32. Interactive chromo-phone
33. Puppets that you put on a device with a speaker with RFID tags in it; Eat like a ... (zen monk (quiet), turtle (chews slowly), explorer (consciously tasting); telling an calming story with mindful (eating) exercises
34. Theme board/presentation + cards with tags in them that children can choose theme/character which will teach them about healthy eating behavior with a reward at the end (familiar sound or something)
35. "Apps" on digital board with little distraction/movement but something visual + sound
36. Make doll/animal smart –> put food items with tags in hand/mouth after which something happens related to healthy eating behavior
37. Christmas lights garland around the classroom to determine time + hang images at certain points regarding mindful eating
38. A robot that drives through the classroom and asks questions to children
39. A kind of tamagotchi that children have to maintain by eating themselves
40. AR hologram on each table
41. Gesture controlled speaker
42. Cards that are on the table in groups that promote commensality

43. Projection on tables with different surfaces with options on how someone feels about the food and then receive answers with disks (+ image processing)
44. A system with which you can adjust the light in the classroom
45. Visual animations such as an animated timer with an animal or mascot or item
46. Interactive elements such as a reward system in which children earn something if they eat quietly
47. Smart card system with pictograms that make the lunch process clear (such as "eat now", "5 more minutes", "clean up")
48. A placemat that children can move a disk over to get information/questions
49. Card game where children learn about nutrition
50. Gamification where children can earn points if they eat something well or rewards if they are the quietest table, for example
51. Dashboard on digital board where teachers can see, among other things, the sound level (with traffic light principle, maybe)
52. Automatic prompts or reminders for teachers to keep routines running smoothly
53. Digital "lunch passport" in which they can keep track of whether they are eating mindfully/healthily
54. Smart lunch box with sensors (including weight), maybe with connection with parents/teacher
55. Small wearable bracelet that helps children remember to eat mindfully (e.g. by vibrating or coloring)
56. Large (soft) button on the table per group that children can press if they want a mindfulness exercise
57. ASMR audio
58. Voice that is only activated when it is quiet enough
59. Soothing sounds between story/voice
60. Reflection: children can choose a smiley or color how they feel after lunch
61. We can hold a fabric version of food with tag against the lunch box and then audio starts
62. A device which "spits out" a card with a question or a statement every so often
63. Farmers that tells with audio about where food comes from and how it grows (out of a little audio device, can be per group)
64. Ik eet, ik eet wat jij niet eet en het is...
65. Cuddly toys made of vegetables and food, when you press them, an audio will play with information about that particular vegetable or food + mindful eating exercise.

66. Box or drawer where children can put all distractions related to school so that children can focus
67. Separate corner in the classroom where restless children can relax with acoustic panels
68. A (half) turntable which "state" the classroom has to be in (completely quite, or very quite talking, etc.); which you can also automate that after period of time it goes to another "state"
69. RFID tags in lunch box: if you hold lunch boxes against each other, audio starts with social questions about food
70. Plant that grows when children eat well (mindful) and calmly
71. Lunchbox with specific shapes; Shape forces filling
72. Bring your favorite red fruit (or other things)
73. Learn about a new fruit, vegetable or other healthy food every week (maybe with a sort of grab bag)
74. Monthly eating challenge
75. Buddy system where you learn about the food in each other lunch box and where you encourage each other to eat mindful
76. Escape room eating puzzles
77. Eating toolkit for every child with stuff like hourglass, cards with icons of body parts to scan how they feel, etc.
78. Sticky notes which children have to stick to a certain feeling or emotions after the lunch
79. Tag in a box to express your emotion after lunch which automatically gives results to teacher
80. Audio voice that on certain moments give time updates
81. Info graphic which provides an overview of the order in which children have to eat certain types of food
82. Draw your lunch or something when you are finished with eating
83. Screen on each table that shows an icon that means something (e.g. that they should listen to their body, or that the time is half over, etc.)

B.2 First iteration round using SCAMPER

1. An meditation animal/mascot/plant that tells a story with in between mentioning/asking mindfulness and mindful eating questions (1+17)
   (a) Voice that is only activated when it is quiet enough (58)
   (b) With at the end reflection (60)
   (c) With soothing sounds or calming music (3)

2. Dashboard on digital board where teachers can see the sound level (with easy traffic light principle) including art for a calm environment (16+51)

3. A (half) turntable which "state" the classroom has to be in (completely quite, or very quite talking, etc.); which you can also automate that after period of time it goes to another "state" with on the border a ring with LEDs as a countdown mechanism (2+68)

4. A robot that stands in front of the class telling a pre-recorded story that asks mindful eating questions in between which can act as a teacher (17+23)

5. A type of Beebot that takes steps forward relative to the time to a certain finish point and in the meantime tells a spoken mindful eating meditation (1+27)

6. Ik eet, ik eet, wat jij niet eet.. with follow up questions that encourage the social side of lunch (29+64)

7. A slider on a place mat to indicate things like how full you are, how the food taste, how you feel, etc. (22+48)

8. A device on every group of tables with a screen showing icons that mean something with an info graphic in which order they have to eat certain type of food with a small speaker playing calming music (81+83+3)

9. A wearable that can convey tactile calm breathing and augments users to hear a pre-recorded story that asks mindful questions in between. (14+24+17)

10. Discuss your favourite... (e.g. red fruit, green vegetable, etc.) (72+29)

11. An app/website/dashboard in which you can choose a theme or character. Then you can play an audio (mindful story or calming music). The sound level of the class will be measured, if too loud –> an supportive question will be asked if the children want to lower their volume. (3 en of 17 +51+58(reverse)+33(theme/character)

Ideas from previous round that were already as desired:

12. Puppets that you put on a device with a speaker with RFID tags in it; Eat like a ... (zen monk (quiet), turtle (chews slowly), explorer (consciously tasting); telling an calming story with mindful (eating) exercises (33)

13. Small wearable bracelet that helps children remember to eat mindfully (e.g. by vibrating or colouring) (55)

B.3 Second iteration round

1. An meditation animal/mascot/plant that tells a story with in between mentioning/asking mindfulness and mindful eating questions. In addition the voice that is only activated when it is quiet enough and soothing sounds/music can be played. In the middle a time indication will be given and at the end a reflection moment for social aspect of lunch.

3. A (half) turntable which "state" the classroom has to be in (completely quite, or very quite talking, or when they may have a moment for complete social interaction etc.);

which you can also automate that after period of time it goes to another "state" with on the border a ring with LEDs as a countdown mechanism.

4. A Robot that stands in front of the class that asks mindful eating questions in between which can act as a teacher. In addition, it can teach about healthy diet, give time indications and provide room for social interaction after the story has ended.

8. A device on every group of tables with a screen showing icons that means something with an info graphic in which order they have to eat certain type of food with a small speaker playing calming music. In addition an LED ring around the screen can indicate the time left and towards the end the icon on the screen can show it is time for some social interaction.

11. An app/website/dashboard in which you can choose a theme or character. Then you can play an audio story with integrated mindful eating questions, info on healthy diet, and social interaction) and calming music. The sound level of the class will be measured and displayed like a traffic light for example. A visual time indication can be displayed as well (for example a ring with lights that will count down).

12. Puppets that you put on a device with a speaker with RFID tags in it; Eat like a ... (zen monk (quiet), turtle (chews slowly), explorer (consciously tasting); telling an calming story with mindful (eating) exercises. This along with healthy diet facts, incorporated elements of social aspects of eating and an audible time indication.

13. Small wearable bracelet that helps children remember to eat mindfully (e.g. by vibrating or colouring). In addition, a visual or haptic time representation can be built in.

Appendix C

Story script

Koe Karel en het geheim van de verdwenen groenten

Introductie
Hallo, ik ben koe Karel, de nieuwsgierige koe van de boerderij! Ik woon samen met mijn boerderijvriendjes op de boerderij van boer Bram. Het is hier heerlijk! Wat fijn dat jullie er ook zijn! Terwijl jullie zo lekker gaan eten, ga ik jullie één van mijn avonturen op de boerderij vertellen. Maar voordat ik kan beginnen, wil ik met jullie de volgende afspraak maken.

Om tijdens mijn verhaal rustig te kunnen eten, is het belangrijk dat jullie op de stoel blijven zitten en goed luisteren. Let er op dat je niet te snel eet, maar zorg wel dat je genoeg gegeten hebt. Op het scherm kan je zien hoe lang jullie nog hebben om te eten. Op de helft van de tijd

Zitten jullie er klaar voor? Eet smakelijk!

Verhaal
Het begon op een zonnige ochtend, toen ik – Koe Karel – net zoals elke dag, buiten in de wei stond te grazen. De zon scheen lekker op mijn rug, de lucht was helderblauw en ik hoorde de vogels vrolijk fluiten. Ik voelde me al een beetje hongerig, want ik had de hele nacht geslapen. Een paar sappige grassprietjes verdwenen al in mijn bek toen ik vrolijk werd opgeschrikt door bekende geluiden.

"Karel! Kaaaaarel! Kom je mee?" hoorde ik roepen vanaf het hek.

Het waren mijn boerderijvriendjes Kip Kaatje en Biggetje Benno. Ze kwamen huppelend en kakelend naar me toe.

"We gaan naar het groenteveld! Boer Bram zei laatst nog dat de sla en wortels bijna rijp waren. Zullen we samen kijken of er iets lekkers is om te eten?" zei Kaatje enthousiast.

"Ja!" knorde Benno. "Ik heb zin in komkommer of een knapperige wortel. Ik heb van boer Bram gehoord dat groenten supergezond zijn. Het zit vol met vitaminen, die helpen je om sterk te blijven en zorgen ervoor dat je minder snel ziek wordt!' "Dus als ik veel groente eet, blijf ik lekker fit en kan ik nog langer spelen?" vroeg kip Kaatje nieuwsgierig. 'Precies!' lachte Benno, "... en weet je wat het leukste is? Het is ook nog eens superlekker!"

Samen stapten we vrolijk richting het groenteveld van Boer Bram. We liepen langs de kippenren, de boomgaard en de hooischuur. De zon scheen warm op ons vachtje en we hadden goede zin. Maar toen we het veld bereikten, bleef Benno plots stilstaan.

"Euh... wat is dit?" snuffelde hij verbaasd.

Ik kneep mijn ogen tot spleetjes en keek goed. "Waar zijn... de groenten?!"

Het hele veld, dat gisteren nog vol stond met wortels, sla, bloemkolen en komkommers, was leeg. Alleen kale aarde en een paar verdwaalde blaadjes lagen op de grond.

"Dat kan toch niet!" kakelde Kaatje. "Wie heeft al het lekkers meegenomen?"

"Misschien is er een groentendief op de boerderij!" riep Benno dramatisch.

We besloten op onderzoek uit te gaan. Onze eerste stop was de hooischuur. Misschien had iemand zich daar verstopt! Toen we binnenliepen, zagen we een paar oranje worteltjes liggen op de vloer. "Aha! Bewijs!" riep Benno. "De dief is hier geweest."

Maar voordat we iets konden zeggen, hoorden we geritsel. Achter een grote baal hooi kwamen onze vriendjes Mats en Mia Muis tevoorschijn. Ze hadden hun wangetjes vol met worteltjes.

"Wat doen jullie daar?" vroeg Kaatje verbaasd. "O, hallo!" piepte Mia. "Wij hebben gisteren een paar worteltjes van het veld gehaald voor onze wintervoorraad."

"Maar... hebben jullie dan alle groenten meegenomen?" vroeg ik verbaasd.

"O nee!" zei Mats. "Zoveel kunnen wij helemaal niet tillen. Het waren er maar een paar."

We geloofden de muisjes – zij waren klein en lief, en zeker niet in staat een heel veld leeg te halen. Dus vervolgden we onze speurtocht.

We liepen langs het kippenhok en de vijver, waar een paar kikkers vrolijk kwakten. Toen kwamen we bij de appelgaard. De bomen hingen vol met sappige appels.

"Die zijn gelukkig niet verdwenen!" zei Kaatje opgelucht.

Benno kreeg meteen een idee. "Ik wil een appeltje!" Hij duwde met zijn snuit tegen de stam van de grootste boom.

"Pas op!" kakelde Kaatje nog, maar het was al te laat. Een grote rode appel viel precies op Benno's kop.

Hij wankelde even, maar lachte toen. "Misschien moet ik iets voorzichtiger zijn!"

Hij pakte de appel op en nam een grote hap. "Mmm, zoet en knapperig!" zei hij met

volle mond.

“Wist je dat het heel belangrijk is om goed te kauwen?” vroeg ik. “Als je rustig en genoeg kauwt, proef je beter hoe lekker iets is én help je je buik om het eten goed te verteren.”

Kip Kaatje knikte: “Ik tel altijd tot tien als ik een hap neem. Dan weet ik zeker dat ik goed heb gekauwd!”

Benno moest lachen. “Nou, dan ga ik dat ook proberen.” En hij kauwde extra langzaam, terwijl zijn oortjes vrolijk wiebelden.

We genoten van de appels en lachten samen. Maar ons avontuur was nog lang niet voorbij... Want we wisten nog steeds niet wat er met de groenten gebeurd was!

Beste kinderen, de helft van ons avontuur zit er nu op en dat betekent dat jullie eten ook ongeveer voor de helft op zou moeten zijn! Kijk eens in je broodtrommel. We hebben nog even de tijd, maar het is slim om ervoor te zorgen dat je alles rustig kunt opeten!’

Samen met Kaatje kip en big Benno ging ik verder opzoek naar de verdwenen groenten. We liepen naar de wei, waar we Schaap Suus zagen grazen. Ze keek op toen we eraan kwamen.

"Hoi Suus! Ben je lekker aan het eten?" vroeg ik. "Ja," mekkerde Suus. "Het gras is heerlijk, maar ik had vandaag eigenlijk zin in worteltjes. Die groeien toch naast het veld?"

Benno keek sip. "Daar stonden ze, ja. Maar nu zijn ze allemaal weg. Waarschijnlijk heeft de groentedief alles meegnomen!” We willen weten wie hier achter zit!”

Ik vertelde Suus over ons onderzoek. Ze spitste haar oren. “Nou, dat is wel heel erg vreemd. Ik zag gister nog niks raars. ”Dan ga ik met jullie mee. Ik wil het zelf wel eens zien!"

Met z’n vieren liepen we terug naar het lege veld. En ja hoor... nog steeds niets. Maar toen... zagen we beweging aan de rand van het veld. Ze kropen allemaal achter mijn grote rug. “Is dat misschien dan onze dief waar we naar opzoek zijn?” Oeh wat was het spannend. Het geluid kwam dichter bij. En daar kwam plots ons vriendje Koosje het konijn tevoorschijn, met grote sprongen kwam hij naar ons toe. “Jeetje, Koosje! Wat liet je ons schrikken!” Mekkerde Suus.

"Hoi allemaal! Waarom schrikken jullie van mij en waarom kijken jullie zo sip?”

Kaatje legde uit: "Gisteren stond dit veld nog vol met heerlijke groenten. Nu is alles weg en we weten niet waarom."

Koosje knikte. "O, maar ik weet wat er is gebeurd! Vanochtend heel vroeg zag ik Boer Bram alle groenten oogsten. Hij had zijn aanhanger achter de tractor gezet en haalde alle wortels, sla, bloemkolen en komkommers van het land." "Dus... hij heeft ze niet weggegooid?" vroeg Benno verbaasd.

"Nee hoor!" zei Koosje. "Hij bracht ze naar de winkels in het dorp, zodat de mensen ook van de lekkere groenten kunnen genieten."

"Ahaaaa!" zei ik. "Dus dat is het geheim van de verdwenen groenten!"

"En weet je wat het leukste is?" ging Koosje verder. "Boer Bram heeft gezegd dat hij deze week alweer nieuwe zaadjes gaat planten. En over een tijdje staan hier weer verse groenten!"

Suus mekkerde blij. "Wat fijn! Dan kunnen we binnenkort weer samen smullen."

We sprongen en dansten van blijdschap. Gelukkig was er geen groentedief op de boerderij. De zon stond hoog aan de hemel en het geheim van de gestolen groente was opgelost. Jippie!

Sociale aspect
En terwijl we terugliepen naar de schuur, bespraken we met elkaar welke groenten wij het lekkerst vinden. Schaap Suus is namelijk dol op sla. En Koosje Konijn lust het liefst worteltjes. En ik... ik ben gek op Bloemkool. Trouwens, zijn jullie (in de klas) al bijna klaar met eten en drinken? Vertel dan eens aan je buurvrouw of buurman: welke groente jij het allerlekkerst vindt?

Afsluiting
Wat leuk om jullie zo enthousiast te horen! Wat fijn dat iedereen weer iets anders lekker vindt – zo is er voor ieder wat wils. En weet je? Door samen te praten over wat je eet, ontdek je soms zelfs iets nieuws dat je misschien ook wel eens wilt proeven! Ik hoop dat jullie lekker en genoeg hebben gegeten en gedronken. Tot het volgende avontuur op de boerderij van boer Bram!

Appendix D

Data collection methods

In this appendix, several data collection methods are presented utilised during this research.

D.1 User context teacher interviews

Interview vragen leerkrachten

Algemene ervaring:

1. Kunt u kort beschrijven hoe de lunch op een typische dag verloopt in uw klas?
2. Wat zijn de belangrijkste taken die u zelf uitvoert tijdnes de lunch?
3. Heeft de lunchpauze invloed op de manier waarop de rest van de schooldag verloopt? Zo ja, op welke manier?

Uitdagingen tijdens de lunch:

4. Wat zijn de grootste uitdagingen die u tegenkomt tijdens de lunchpauze?
5. Zijn er specifieke dingen die u mist in de huidige organisatie van de lunch?
6. Zijn er gedragingen of problemen van kinderen die lastig te managen zijn tijdens de lunch?

Wensen voor een betere lunchomgeving:

7. Wat zou een ideale lunchpauze voor u zijn, qua ondersteuning en organisatie?
8. Welke vormen van ondersteuning zouden u kunnen helpen om de lunchpauze soepeler te laten verlopen?
9. Zijn er specifieke middelen of ideeën die u zou willen inzetten om de lunchervaring voor zowel de kinderen als uzelf te verbeteren?

Jonge kind:

10. Welke specifieke behoeften hebben jonge kinderen tijdens de lunchpauze?
11. Welke vormen van begeleiding hebben jonge kinderen nodig tijdens de lunch? Openen van dingen bijv.?
12. Zijn er specifieke ontwikkelingskenmerken van jonge kinderen waarmee ik volgens u rekening moet houden?

Afsluiting:

13. Heeft u nog ideeën of opmerkingen die u wilt delen die nog niet aan bod zijn gekomen?
14. Mag ik u per mail nog contact zoeken indien naar aanleiding van dit interview nog vragen opkomen?
15. Zou u open staan voor een vervolg onderzoek bij de evaluatie fase?

FIGURE D.1: Interview questions user context teachers

D.2 Exploratory user evaluation

D.2.1 Observations

Deel 1: Observatieschema (tijdens luisteren/eten)

Observatiecategorie	Beschrijving	Aantekeningen
Start betrokkenheid	Hoe reageren de kinderen bij de start? (Nieuwsgierig? Afwachtend?)	
Aandacht vasthouden	Momenten waarop ze afdwalen (wegkijken, friemelen, praten, etc.)	Afgeleid:
Eetgedrag	Eten ze rustig door? Stoppen ze met eten? En op bijzondere momenten (zoals kauwen, tijd, etc.)	
Emotionele reacties	Lachen, verbaasd kijken, meebewegen, fronsen	

FIGURE D.2: Observation table exploratory user evaluation part 1

Observatiecategorie	Beschrijving	Aantekeningen
Interactie met verhaal	Reageren ze op gebeurtenissen in het verhaal (bijv. "Oh nee" roepen)?	
Visualisatie	Kijken ze naar visualisatie? Reageren ze erop? Leidt het niet te veel af?	
Algemeen gedrag	Actief luisteren, passief, afgeleid door omgeving?	
Sociale aspect	Wat gebeurd er in die minuut? Te lang, te kort?	

FIGURE D.3: Observation table exploratory user evaluation part 2

D.2.2 Questions

FIGURE D.4: Visual response scale for questions

Evaluatie-experiment Kinderverhaal

Algemeen

- Leeftijd kind 1:
- Leeftijd kind 2:
- Concept/versie getest:

Deel 2: Vragenlijst Nabespreking

Inleiding:
"Ik vond het heel leuk dat jullie naar het verhaaltje hebben geluisterd! Ik heb een paar vragen voor jullie. Er zijn geen foute antwoorden! En als je iets niet snapt, mag je dat gewoon aangeven!"

1. Emotionele betrokkenheid en interesse

- "Hoe vond je het verhaaltje?" (Kind kiest een smiley)

- "Waarom vond je dat?"

_____

_____

_____

- "Wat maakte het leuk / spannend / grappig?

_____

_____

_____

- Zou benieuwd zijn naar het volgende avontuur op de boerderij van boer Bram, bijv. Het verhaaltje van schaap Suus?

_____

_____

_____

2. Begrip

- Weet je nog wat kip kaatje altijd doet, zodat ze goed kauwt?

_____

_____

_____

- Wat gebeurde er in het verhaaltje toen de dieren bij de appelbomen waren aangekomen?

_____

_____

_____

- Wat heeft de boer met de groenten gedaan?

FIGURE D.5: Evaluation questions exploratory user evaluation part 1

3. Visualisatie
- Wat vond je van het plaatje/de tekeningen? (Smiley) Doorvragen

5. Sociale aspect
- Vond je het leuk om tussendoor even met elkaar te mogen praten over je lievelingsgroente? Smiley

- Waarom vond je dat?

Extra notities
Opvallende opmerkingen/gedragingen tijdens nabespreking:

FIGURE D.6: Evaluation questions exploratory user evaluation part 2

D.3 Teacher perspective evaluation

Leerkrachten Interviews

Doel:
Wat vinden leerkrachten van het concept (ondersteund het hen) en wat is hun kijk op de implementatie van het concept in de praktijk?

Meetmethode:
Presentatie concept (uitleg proces van onderzoek naar concept en uitleg concept) vervolgt door interview (semi gestructureerd)

Inzichten:
1. Ondersteunen leerkracht
2. Implementatie in de praktijk
3. Bijdrage rustige omgeving
4. Stimulering gezond eetgedrag bij kinderen
5. Educatieve waarde

Vragen:
1. Helpt het concept om het lunchmoment makkelijk te begeleiden? Waarom wel/niet?
2. Wat ontbreekt er of wat is er overbodig?
3. Zouden de controle functies in de web applicatie voor u ondersteunend werken of had u dat liever op een andere manier gezien?

4. Ziet u zichzelf dit gebruiken in de praktijk? Waarom wel/niet?
5. Denkt u dat het eenvoudig in te zetten is binnen uw klas?
6. Past het concept binnen de gewenste structuur van het lunchmoment?
7. Wat zou u nodig hebben om dit goed te kunnen gebruiken? (Denk aan tijd, middelen, begeleiding)

8. Zou deze interventie kunnen bijdragen aan meer rust en structuur tijdens de lunch? Waarom wel/niet? Zijn er bepaalde aspecten die hier wel/niet aan kunnen bijdragen?
9. Denkt u dat de visualisatie in de web applicatie een toevoeging is voor kinderen? Icoontjes, tijdsindicatie?

10. Denk u dat kinderen door dit concept bewuster om kunnen gaan met eten?
11. Zijn de interventie momenten (statements) een goeie manier om een gezond eetgedrag aan kinderen mee te geven?
12. Hoe verwacht u dat kinderen op dit concept zouden reageren?

13. Op welke wijze kan het aansluiten bij lesdoelen waar jullie in moeten voorzien?
14. Zou u dit als onderwijstijd kunnen verantwoorden?

Slot:
15. Heeft u verder nog opmerkingen, ideeën of suggesties die u met mij wilt delen?

FIGURE D.7: Evaluation questions teacher perspective evaluation

D.4 Class observations

Donderdag / Vrijdag

Deel 1: Observatieschema (tijdens luisteren/eten)

Observatiecategorie	Beschrijving	Aantekeningen
Start betrokkenheid	Hoe reageren de kinderen bij de start? (Nieuwsgierig? Afwachtend?) Is de aandacht er meteen bij?	
Aandacht vasthouden	Momenten waarop ze afdwalen (wegkijken, friemelen, praten, etc.) En wanneer Waar kijken ze naar (in normale situatie), wat doen ze	
Eetgedrag	Eten ze rustig door? Stoppen ze met eten? Hebben ze het eten op? Hebben ze hun broodtrommel op?	

FIGURE D.8: Class observation scheme part 1

Donderdag / Vrijdag

Visualisatie	Kijken ze naar visualisatie? Reageren ze erop? Leidt het niet te veel af? Tijdsindicatie?	
Algemeen gedrag en sfeer	Actief luisteren, passief, afgeleid door omgeving? Algemene sfeer in de klas?	
Sociale aspect	Hoe verloop het sociale contact wanneer het mag? Praten ze samen op een rustige manier? Praten ze over het gevraagde onderwerp of over andere dingen? Te lang, te kort?	

FIGURE D.9: Class observation scheme part 2

Donderdag / Vrijdag

Interventies	Reageren ze op bijzondere momenten (zoals gezond groenten, kauwen, tijd)	
Leerkracht ondersteuning	Nabespreking leerkracht	

FIGURE D.10: Class observation scheme part 3

Donderdag / Vrijdag

Observatiecategorie	Turven
Praten de kinderen door het verhaal?	
Moet de leerkracht ingrijpen?	
Stoppen ze met eten door het verhaal?	
Hulp vragen bij eten: 1. Aan elkaar 2. Aan leerkracht	
Overig: 1. Ongelukjes 2. 3.	

FIGURE D.11: Class observation scheme part 4