# Kitchef: A TUI for Parent-Child Cooking Together

Noa Morag Yaar
noa.morag@milab.idc.ac.il
Media Innovation Lab
Reichman University
Israel

Ofir Sadka
ofir.sadka@milab.idc.ac.il
Media Innovation Lab
Reichman University
Israel

Itay Shatil
shatil95@gmail.com
Media Innovation Lab
Reichman University
Israel

Maayan Aharonson
maayanaharonson@gmail.com
Media Innovation Lab
Reichman University
Israel

Bar Efrima
bar2798@gmail.com
Media Innovation Lab
Reichman University
Israel

Tal Barda
talbarda8@gmail.com
Media Innovation Lab
Reichman University
Israel

Mira Hayat
mira11315@gmail.com
Media Innovation Lab
Reichman University
Israel

Oren Zuckerman
oren.zuckerman@milab.idc.ac.il
Media Innovation Lab
Reichman University
Israel

Hadas Erel
hadas.erel@milab.idc.ac.il
Media Innovation Lab
Reichman University
Israel

## ABSTRACT

The benefit of cooking with children goes beyond the act of preparing food. Studies highlight how cooking together can help children develop openness to diverse food, a sense of independence, and can enrich the parent-child relationship. However, challenges such as parents concerns from the messy process and children's lack of engagement, often hinder the motivation to cook together. We present the design and preliminary evaluation of a Tangible User Interface (TUI) for encouraging parents and children to cook together. The TUI is designed as a cooking recipe smart box and a pair of wristbands. A preliminary study with five families revealed that the TUI was successful in allowing for more control and visibility while maintaining flexibility in the cooking process. It also enhanced teamwork, high engagement, and physical closeness. Our results suggest that the TUI can assist parents and children in cooking together.

## CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**.

## KEYWORDS

TUI, Parent-child interaction, Cooking together

**ACM Reference Format:**
Noa Morag Yaar, Ofir Sadka, Itay Shatil, Maayan Aharonson, Bar Efrima, Tal Barda, Mira Hayat, Oren Zuckerman, and Hadas Erel. 2024. Kitchef: A TUI for Parent-Child Cooking Together. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '24), May 11–16, 2024, Honolulu, HI, USA.* ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3613905.3650970


*CHI EA '24, May 11–16, 2024, Honolulu, HI, USA*

ACM ISBN 979-8-4007-0331-7/24/05
https://doi.org/10.1145/3613905.3650970

## 1 INTRODUCTION

Cooking together with children imparts new habits, trains important cooking skills, and even reduces the development of food-related disorders [10, 17]. Studies have shown that the inclusion and involvement of children in food preparation, may encourage exposure and openness to new and more diverse types of food [1, 9, 37], promote children's health [24, 25], and contribute to the development of creativity [36]. Overall, it was found to increase positive feelings of empowerment, independence, ownership, and self-esteem among children [2, 8, 12, 17, 33]. The inclusion of children in the cooking process alongside the parent, creates an opportunity for the child to learn from an experienced parent and gradually become a responsible adult [37].Furthermore, performing collaboratively in the kitchen has been demonstrated to induce open communication between the parent and child, which contributes greatly to the relationship between them [24, 36, 37].

Despite the many benefits of cooking together, parents often exclude children from the cooking process for a variety of reasons. Parents may feel overwhelmed by the potential mess in the kitchen [28], or view cooking as a chore that requires strict supervision. Children, on the other hand, may become disoriented and lose their motivation along the process, whether because the process is unclear or the cooking experience is falling short of the promised fun and engagement.

There are several strategies to encourage families to cook together. For example, cooking workshops that aim to help parents integrate children into the cooking process. These workshops have been successful in enhancing parenting practices that support child involvement and autonomy around the kitchen [35]. Another approach is the design of child-friendly cooking books, toys, kitchen utensils, and TV programs [15].

Various technologies have also been suggested to support cooking, such as smart systems to improve the process of preparing food,


**Figure 1: Kitchef: A smart recipe box and a pair of wristbands to motivate parents and children to cook together. Every recipe includes distinct steps, clearly indicated by illuminated hollow circles. These circles light up each time the parent and child attach their wristbands, signifying the completion of a cooking step.**

systems which suggest ideas for recipes based on the availability of ingredients in the house, and smart utensils which support the process [18, 23, 31]. Other technologies have been integrated to allow cooking together, such as a smart interface for multi-users to work together [3, 20], or fun activities, games and mobile application to teach children how to cook [7].

While these solutions may encourage and enhance cooking, they are not directed to answer challenges imposed by the specific dynamic between parents and children in the kitchen. In this study, we explore the possibility of leveraging a TUI to motivate parents and children to cook together. TUIs have been found to encourage physical closeness and mutual exploration [16, 38]. Moreover, studies including TUIs have shown how the tangible exploration can enhance parent-child collaboration [30], and may play as a motivator for change in human behavior [26]. We present the design and preliminary evaluation of Kitchef, a TUI that consists of a smart recipe box and two wristbands, one for the parent and one for the child. The TUI is designed to allow a structured process to enhance a sense of control for the parent and a wider perspective of the process for the child. The wristbands promote a sense of equality between them to increase involvement and engagement. The system is also designed to induce physical gesture that promotes a sense of togetherness between the parent and child.

## 2 RELATED WORK

Previous research includes studies evaluating the impact of TUI for parent-child interaction and technologies in the context of cooking.

### 2.1 TUI for Parent-child interaction

TUIs have demonstrated their effectiveness in facilitating collaborative work and fostering social interaction [19]. It was also found that TUI can be highly stimulating and enjoyable [38]. TUIs contribute to social interaction and introduce a new form of communication [4, 6, 11, 21]. In parent-child interaction, a TUI was shown to maintain important family bonds in a situation where parents and children don't share the same space [32]. In addition TUIs were also proven to raise awareness in a parent-child interaction. For example, in the study by Sadka et al. (2018) a simple TUI raise parents' awareness of the various roles parents can take during a collaborative activity with their child [30], and in another study by Morag et al. (2023), a TUI raised awareness to mobile distractions around the dinner table which led to a behavioral changes and allowed togetherness during dinner time [26].

These works show the potential of TUIs to impact parent-child communication and enhance collaboration and a sense of togetherness. We extend this line of work by designing a TUI for parent-child collaboration in the context of cooking.

### 2.2 Technologies in the kitchen

HCI highlights the potential of smart devices to augment social interactions in the kitchen as well as allow the opportunity to learn about cooking and food ingredients [29]. In the specific context of parent-child cooking, the e-Care dining table is a tabletop screen embedded in the kitchen with educational content for children. Aimed at 5-9 years old, children are presented with interactive games and need to answer questions about fruits and vegetables, and participate in activities related to a recipe their parent is currently making [7]. In the context of family members cooking together, the CounterActive is an interactive cookbook that projects images, videos, and audio of recipes onto the kitchen counter [20]. The La Cantina system projects ambient information such as web pages and video onto a kitchen counter for guiding multi user cooking process. Their study found that Visual cues are effective in guiding the collaborative cooking process [3]. Similarly, Terrenghi et al.(2009) designed the Living Cookbook project to display multimedia content, where members of the family create, edit, and share recipes [34]. Findings have shown how such an engaging content can facilitate communication and cooking together.

In this work, we would like to leverage the potential of the TUI to foster collaboration between parents and children during cooking activities. Unlike previous studies that contributed to the process and the overall experience of cooking, we explored the possibility

of designing a TUI that can enhance the dyadic experience while answering the needs of both parents and children in this context. The TUI is designed to structure the process allowing the parent a sense of control, while simultaneously allowing children to have fun and feel equally responsible and empowered.

## 3 DESIGN

The design process described below follows the Human Centered Design approach (HCD), where needs are first identified with experts and relevant users, following by an iterative design process of prototypes.

### 3.1 Need Study

To identify specific needs in the context of cooking with children, we first conducted interviews with four experts: a nutritionist, a parental consultant, and two developmental psychologists. We understood that eating disorders can evolve at a very young age and that children's involvement in food preparation can have a positive impact on their eating habits. A nutritionist said, "In an age saturated with media and stimuli, many children develop body image problems and eating disorders".

Following the academic literature emphasizing the importance of early exposure to food preparation [17, 37], We focused on the parent-child interaction during meal preparation. We interviewed and observed three families with children aged 4-8 to better understand their cooking routines at home (See table 1). Parents expressed their understanding of how important and meaningful cooking together is: "It is very important for me to cook with my kid" [P1, F36], and also that their children enjoy cooking with them: "My son loves to cut vegetables and taste everything we make" [P3, F36]. Yet, they also voiced their challenges such as the mess in the kitchen: "My daughter loves to cook but she makes a mess each time she is there" [P2, F35]. Next, we observed two families baking cookies with their children. We noticed how chaotic and stressful the experience was for both of them. One child said, "Now it's my turn, now me!" [P4, M5], another child got bored very quickly [P5, M5], and one mother even warned her child that "If you leave now, you won't be able to watch TV!" [P3, F36]. Additionally, we observed that children were often assigned simple tasks, limiting their awareness of the entire process. Also although positive feedback was rare, it was highly valued by the children. In addition the parents demonstrated a strong need for control and appeared intimidated by the kitchen's demands. Referring to academic literature we found that at the age of five, children start developing competence and independence [14]. This stage is marked with high learning ability and curiosity [2]. Involving them in the process of cooking while allowing them to perform tasks and understand what is behind the process, was found to be critical for cultivating a sense of independence and competence [13, 17].

We decided to focus on children in the age group of 5-8. To help us define the challenges, pinpoint the context of use and craft a solution, we started by imagining two personas, one for the child and one for the parent, and gave voice to their struggles and challenges based on the interviews and observations. The parent persona voiced the motivation to maximize enjoyable moments with their children, while also maintaining control over the kitchen mess and the cooking process. The child persona portrayed a child who is curious about the process and the suggested joint activity, but can get easily bored with the cooking. We realized that our solution needs to foster more structured yet fun and engaging cooking activity for the parent and child.

### 3.2 Iterative Prototype Design

For our first prototype we decided to create ***a turn taking device*** to help with the desire of control over the cooking process voiced by the parents in the interviews, while keeping it engaging for the children. Our prototype included a rectangular object with a piece of wood in the middle that can slide from "parent" to "child" (see figure 2). The position of the rectangular indicated who is the chef (the top) and who is the sous-chef (the bottom) at any given time. After the chef's turn, she flips the box and then roles are reversed. The box also indicates the number of steps to conclude the recipe. We asked two families to prepare a recipe using this box and observed the interaction (see table 1). The children and parents were enthusiastic about the interaction with the turn taking device: "Dad I am flipping you now" [P5, M5], "This time dad will flip and you will flip next time" [P6, M46]. We observed a "high five" gesture when they completed a step. However, we noticed that turn-taking diminished the collaborative cooking as each time it was made clear who was in charge. Also, many times, the steps of the recipe were forgotten, or they didn't know how many tasks count for a complete step.

For our next prototype, we wanted to allow a more collaborative activity where the parent and the child are equally involved and responsible in the process. We started prototyping with the idea of ***wearable wristbands***. We believed that pairing wristbands, one for the parent and one for the child, would inspire a sense of teamwork between them. In addition we were hoping to encourage some gestures, such as the "high five" gesture we previously observed. To test our idea, we created a fabric band with a wooden chip in the center to indicate where the actual touch should occur (see figure 2). We tested the idea on two additional families (see table 1). We asked them to wear the wristband and follow a recipe of their choice. We explained that they needed to mark each step with the band without explicitly telling them what to do. We observed that wearing the wristbands was accepted with joy and smiles. One child immediately made a muscle gesture [P7, F6]. Children who participated also associated the bands with superpower abilities: A child said: "I feel like Captain America" [P7, F6], "Aw we have the same bands! I am a wonder woman" [P8, F8]. Additionally, after completing a step, they instinctively linked the wooden chips on the wristbands, and in several cases it was also accompanied by a shout, "One more time, Mom!" [P7, F6], "We are amazing" [P8, F40], and a "high-five" gesture. Also, we noticed physical and emotional closeness, such as hugs, petting, and smiles. We observed a shift in parental communication from directive language, such as "do this" or "bring that", to a more inclusive and plural tone: "let's put the cake in the oven" [P8, F40], or "Now we need to mix the two bowels" [P7, F38]. Overall, using the wristbands has made parent-child interaction more inclusive and engaging.

We continued to iterate with the design of the wristband by changing the fabric, the size and its optimal position on the wrist.

**Figure 2: Sample of three main prototypes, from left to right: A turn taking device, A pair of wearable wristbands, A recipe box . .**

We added a magnet and tested with users (see table 1) that it clicked better. The magnet added feedback that was appreciated by both of them. "This is fun!" [P9, M7], "Let's attach again!" [P11, M9]. In these user testing we also introduced our third prototype in the shape of a ***recipe box*** (see figure 2). We wanted to allow the recipe more presence in the process and to encourage a more structured experience while maintaining the flexible nature of the cooking. We assumed that a designated box with step-divided recipes would reduce confusion and provide children with a complete process perspective. Unlike the previous turn taking prototype, the box clearly states the steps but doesn't dictate turns. We designed a new recipe with four clear steps and deliberately employed plural instructions to enhance inclusiveness. The box was produced from wood, and the recipe was fabricated from PLA. To emphasis the steps even more, we added a LED light next to each step in the recipe. Using a Wizard of Oz (WOZ) technique, where the researcher remotely controlled the TUI, yet participants perceived it as functioning autonomously [22], we turned the LED lights on after they attached the wristbands. In a user test with three additional families (See table 1), we instructed them to wear the wristbands and follow the steps shown in the recipe. Every time they attached the wristbands, a white LED light appeared. In a follow up interview we asked about the wristbands, the presentation of lights, and the overall design of the box. Results show that the wristbands were easy to wear and attach. Participants easily associated the attachment of the wristbands to the appearance of the LED light on the recipe, but there was some confusion about which step was completed and which is the current one since all were marked the same color. One mother said, "And what happens when all is finished?" [P11, F38], which made us think we needed to celebrate the completion of the recipe. The box itself was accepted with content: "This is beautiful, I like that the recipe fits the box perfectly" [P11, F38], "It reminds me of a children's wooden toy" [P10, F35]. We concluded that we need to indicate the continuum of the steps more clearly and to add a final feedback when all steps are completed. We iterated more with the opacity of the recipe and the wristbands, making it smaller for the child and bigger for the parent.

## 4 MID FIDELITY PROTOTYPE

Our mid-fidelity prototype includes two wristbands and a smart recipes box (see figure 1. The box is designed to showcase one recipe at a time. Each recipe has four main steps marked clearly with a hollow circle and text instructions. When positioned on the box, the hollow circles on the recipe aligned with a series of LED lights embedded vertically in the box. After choosing a recipe and placing it onto the box, the parent and the child wear their wristband. The parent has a wristband with sensing capability, and the child a band with a magnet only.

Before starting to cook, the parent and the child need to first pair their bands by attaching them one to the other. Once paired, a white LED light on the box highlights the first step on the recipe. The parent or the child reads the instructions of the step out loud and they begin to cook. Once they decide that a step is concluded, the parent and the child attach their wristbands together and a signal is sent to the box via Bluetooth. The feedback of the attachment is felt both in the wristbands (Magnetized feel) and also shown on the box; the current white LED light changes to green (to indicate that they have completed the step), and an additional White LED light appears in the second hollowed circle to indicate the next step. When all steps are completed, the box lights up in a cascade of colorful lights, marking the end of the cooking experience.

### 4.1 The System

The child's wristband contained a magnet, while the parent's wristband is equipped with a XIAO BLE NRF52840 sense controller. This controller is powered by a compact portable battery with an activation switch and connected to a magnetism sensor. This sensor interacts with the magnet in the child's band. When brought into close proximity, the XIAO controller detects the change in magnetism caused by the child's wristband and communicates this data via Bluetooth to an ESP32 controller inside the recipe box. Processing the data in real-time, the RGB LED strip behind the recipe lights up to guide the cooking steps.

## 5 PRELIMINARY EVALUATION

Five families (see table 2) participated in the study that was approved by the ethics committee of the University.

### 5.1 Participants and procedure

Families were recruited for the study with the inclusion criteria that they have at least one child aged 5-8. Two researchers came at a convenient time for the family, and upon arrival, provided a short description of the study and how their confidentiality would be protected. The researcher asked the parent and child to place the

**Table 1: Design Process Study**

| Family # | Parents | Children | Study |
|---|---|---|---|
| P1 | M38, F36 | F10, M8, F5 | Need Study |
| P2 | M38, F35 | F7, M5 | Need Study |
| P3 | M36, F36 | M8, F6 | Need Study |
| P4 | F37 | F9, M5 | Need Study |
| P5 | F35 | F8, M5 | Need Study |
| P6 | M46, F43 | F9, M7 | User Testing |
| P7 | F38 | F6 | User Testing |
| P8 | F40 | F8 | User Testing |
| P9 | M46 | M7 | User Testing |
| P10 | F35 | F5 | User Testing |
| P11 | F38 | M9 | User Testing |

**Table 2: Evaluation Study**

| Family # | Parents | Children | Study |
|---|---|---|---|
| P12 | F35 | F5 | Evaluation |
| P13 | F38 | M7 | Evaluation |
| P14 | M33 | F5 | Evaluation |
| P15 | F37 | F6 | Evaluation |
| P16 | F38 | F7 | Evaluation |

recipe onto the box and to attach their wristbands one to the other when ready to start cooking. The researchers then observed the family from a distance, making sure not to interfere with the natural interaction of the family. After the cooking process was over, the researcher conducted a 15-minute semi-structured interview with the parent and the child separately to gather feedback about their experience when cooking together.

## 5.2 Findings

Three researchers analyzed the transcribed interviews and observation notes using thematic coding [5], progressing from initial themes to mutually agreed themes by discussing inconsistencies. We chose thematic coding as we wanted to uncover the participants' interpretation and meaning of the interaction. The analysis revealed three main themes: (1) Structured process, (2) Playfulness and engagement, and (3) Parent-child togetherness.

*5.2.1 Structured process.* All families used the recipe box as an anchor for the cooking. In the interviews, two parents reported that they usually cook more freely around the kitchen. One a father said: "It's different than what I am used to; I am used to working from the top of my head... it helped to keep the order in the process and connected everybody" [P14, M33]. From observing the families we noticed how they referred to the box and the lights to reassure themselves with their current step and instructions. Participants used the word "steps," which indicated that the steps in the recipe were prominent in the process: "When we finish this step, we will attach the bands and have another green light. we will make everything, one after the other"[P14, M33]. Parents also referred to the box to explain the process of cooking: "See, we are still in the step of collecting the ingredients; when we are done, there will be a green light" [P15, F37]. The explanation went beyond the recipe to explain the structured procedure. When asked why the light is not turned on yet, a father explained "We need to mix, then we will need to pour everything, only then we will do the click and you will see the light" [P14, 33]. Children used the highlighted steps for orientation in the process, making it more transparent for them: "We now have one light, but when we are done, we will have two green lights!" [P14, F5].

*5.2.2 Playfulness and engagement.* Attaching the wristbands at the end of each step was a gesture both parents and children enjoyed. In the interview, children said: "It was so much fun. It lighted the colors that were beautiful and colorful! [P14, F5]. "It's nice and cool. Makes me want to cook with them" [P16, F38]. The observation also revealed that parents and children celebrated the attachment of the wristbands every time they concluded a step. They felt comfortable and even excited to have the effect of the magnetized gesture of the bands and seeing the feedback as LED lights on the box. One father made up a wording to go with the attachment every time they attached it: "hooo... paaa" [P14, M33]. Children smiled and referred to the wristbands: "I want to do another click" [P12, F5], and even made up words like "yay" and hands clapping whenever they attached the bands [P15, F6]. The lights on the recipe box were celebrated as well: "Look dad, we have one green, then we will have two greens, then three, then four!, and when we finish?, (the father asked) we will have colorful lights!" [P14, F5]. We also noticed how both parents and children were engaged in the process. One child realized after a while: "Oh, we already turned the oven, but we needed to do it now" [P16, F7], Another mother asked her daughter is she needed help and the daughter replied: "I want to do it by myself!" [P15, F6], and also voiced a sense of achievement: "Mom, we did it, we did all of this!" [P15, F6]

*5.2.3 Parent-child togetherness.* Parents testified that the TUI helped them feel more together. In an interview one mother said: "It helped us work together" [P16, F38], another said: "I can say that she really enjoyed it. It helped to keep the order in the process and connected everybody" [P14, M33]. They also referred specifically to the wristbands: "The wristband felt like we are working as a team" [P12, F35]. In all our observations, we noticed that the TUI helped the families work collaboratively while keeping the work division between them flexible. For example, when there was a task that needed more than one action, the mother asked, "Now we need to pour and mix. Do you want to pour or mix?" [P15, F37]. The collaborative nature also came into play with their semantics. Both used "we" and "us" in their sentences. For example: "We need to mix now?" [P12, F5], "Bring us the butter" [P14, M33], "Let's take out a measuring cup" [P12, F35]. The togetherness was also felt in compliments parents shared with their children: "Wow, you are a chef; I have a chef child at home!" [P15, F37]. We also noticed how the attachment of the wristbands triggered another unexpected physical gesture, such as a hug or a pet. A Parent hugged her child while attaching the wristbands [P15, F37], or gave a cuddle when they were next to each other [P12, F35].

## 6 DISCUSSION

In this study we designed a TUI for parent-child interaction. In a preliminary evaluation, we tested whether the TUI can be employed in the kitchen and enhance the experience of cooking together. Unlike other TUIs, which enhance the cooking experience itself, our TUI was designed to enhance the interaction between the parent and the child in the context of cooking. Our early evaluation indicated that the TUI enhanced collaboration between parents and children while instilling both structure and flexibility in the activity. Parents and children use the TUI as a guide for the process. The physical design of the box and the lighted steps in the recipe, led to a structured process with the visibility of the entire process. At the same time the interaction with the TUI maintains the flexible nature of cooking together, where tasks are divided in a teamwork manner and negotiated freely between them, and children feel equally important in the process. The attachment of the wristbands led to enjoyment and a sense of togetherness. Our data show how the presence of the TUI in the parent-child interaction was inclusive and engaging. Parents used inclusive terminology and hugged their children. The experience for both parents and children was joyful. They enjoyed the immediate feedback when connecting the wristbands and the physical closeness they felt to one another. The overall results show how the TUI was successful in creating a more collaborative cooking, where both were engaged in the experience.

## 7 LIMITATION

We recognize that the study's preliminary nature involved the participation of only five families. It's essential to consider that family structure and dynamics may mediate the influence of TUI, and this should be investigated over time. Such testing would help identify potential novelty effects. Additionally, there is a possibility of the "good subject effect" in qualitative assessments [27]. To mitigate this limitation, we followed a strict protocol and informed participants that all responses are equally important and valuable.

## 8 CONCLUSION

In this work, we show the great potential of leveraging TUI for parent-child interaction in the kitchen. The TUI encouraged collaboration in an equal, teamwork nature, and promoted high engagement in the cooking process and a feeling of togetherness.

## ACKNOWLEDGMENTS

This project was designed and developed with the help of: Sagi Mamane, Zvi Markfeld and Andrey Grishko.

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