Local Foodie: Experience Design of a Mobile Augmented Reality Application for Tourists to Encourage Local Food Consumption

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ABSTRACT

Food is an essential part of travel experience. Consumption of locally produced food while traveling has the two-fold benefit of providing insight into the local culture and increasing the sustainability of tourism. However, finding local food often requires motivation and effort, as information about food ingredients' origins and supply chains is not easy to discover. This paper presents the three-phase experience design process of a prototype of a mobile augmented reality (MAR) application "Local Foodie" designed to encourage tourists in Finland to consume local food. Adventure, autonomy, and competence were determined as experience goals for the application, and an interactive MAR prototype was created through iterative design. The results of a user evaluation (n=10) of the prototype suggest that the use of the application was intrinsically motivating, and the MAR elements contributed especially to the fulfillment of adventure and autonomy experience goals. Future work could leverage context-awareness and personalization to further enhance the experience of adventure.

CCS CONCEPTS

• **Human-centered computing** → **User studies**; *Mixed / augmented reality*.

KEYWORDS

mobile augmented reality, experience design, tourism, local food, sustainability

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1 INTRODUCTION

Eating local food is an essential element of traveling experience, since food is an integral part of any culture. Food and beverage form a large part of expenditure in tourism; for example, food accounted for 18% of spending among tourists in Finland in 2016 [11]. As the need for sustainable traveling is increasingly evident, encouraging tourists to consume local food is an important aim.

In this paper, 'local food' is defined as food that is prepared of ingredients produced within a short distance of the place of consumption. Consuming locally produced food is in most cases a sustainable choice: in terms of environmental sustainability, it can reduce carbon emissions due to shorter transport chains and reduced storage time [1]; in terms of social sustainability, it can provide rich cultural experiences and connections with local people [1]; and in terms of economic sustainability, it brings more money into the local economy. Local food is also associated with authenticity [28], uniqueness, and fresh ingredients, all of which are attractive to tourists [3]. However, it may be difficult for tourists to find out the origins of food ingredients, and sustainability may not be the top priority in the travel experience. In the context of making decisions about where and what to eat, it should be easy and enjoyable to find and process information about local food offerings. For this purpose, augmented reality (AR) technology could be beneficial, as it allows digital information to be overlaid on real objects or space, which can enhance user experience by reducing cognitive load and cost of accessing information [22].

The aim of this research was to investigate how mobile augmented reality (MAR) technology could be used to encourage tourists to consume local food in their destination. We employed research through design [36] and experience design [15] methods to create an application prototype that could evoke meaningful experiences in tourists. MAR was chosen as the starting point for application design because MAR travel guide applications have demonstrated potential in enhancing tourists' travel experience and providing engaging experiences [21]. The experience design process was carried out in three phases with iterative prototyping. This paper aims to answer three specific research questions:

(1) What needs do tourists have for a local food consumption application?
(2) What kinds of experiences can be designed for tourists' local food consumption using a mobile augmented reality (MAR) application?
(3) What are the design implications for MAR applications for local food consumption?

2 RELATED WORK

2.1 Experiential Elements in Tourists' Food Consumption

Tourists can be segmented into different types based on their food consumption attitudes and behaviors. One study presented four tourist types related to food: *existential*, *experimental*, *diversionary*,

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and *recreational* [17]. Existential tourists seek authentic local cuisine and new knowledge, experimental tourists look for famous foods or restaurants with a stylish atmosphere, diversionary tourists choose a general restaurant that they can easily find, and recreational tourists are not particularly interested in food and prefer familiar foods [17]. Another study classified tourists into three types for their food attitude: *experiencers* travel to gain original food experience, *enjoyers* have a casual but positive attitude towards food, and *survivors* have little or no interest in food beyond satisfying their hunger [4]. The two studies implicate that different types of tourists have an active or passive attitude towards local food in their travel destination, and this influences how actively they look for information about local food. Hence, the way of providing information related to local food could be adapted for different tourist types, depending on the kind of experiences they seek.

Furthermore, several studies have investigated factors that influence tourists' food consumption behavior. Randall and Sanjur [27] distinguished three main factors: individual, food, and environment. Building on this work, Mak et al. [23] identified five influential elements under the 'individual' factor: cultural/religious influences, socio-demographic aspects, motivational factors, food-related personality traits, and exposure effect/past experience. Motivational factors were further defined as five traits: symbolic, obligatory, contrast, extension, and pleasure. *Symbolic* indicates the desire to seek traditional status, authentic experience, and explore local food; *obligatory* relates to physical needs to keep one's body healthy; *contrast* refers to motivation to look for something new and breathtaking; *extension* means an inclination to continue one's daily life with familiar tastes or behavior of food consumption; and *pleasure* refers to pursuing amusement through food experiences. These elements bear similarities to the model of food consumption in a travel destination proposed by Kim et al. [20]. The model includes a category of motivational factors, which consists of nine elements: *exciting experience*, *escape from routine*, *authentic experience*, *sensory appeal*, *health concern*, *learning knowledge*, *togetherness*, *prestige*, and *physical environment* [20]. Thus, motivational factors appear to be a key element for understanding travelers' food consumption behavior and potential experience goals. Based on the two studies [20, 23], the motivational factors can be summarized as follows:

- Personal: individual characteristics such as social/cultural background and preferences such as a healthy diet.
- Familiar: previous experience and the degree of exposure to certain foods.
- Locality-aware: trying authentic food, learning about local food culture, or experiencing the physical environment in a meaningful way.
- Novel/diverse: seeking new and varied foods away from routine.
- Enjoyable: sensual or emotional pleasure from a unique food itself or relationship with others regarding food.

Our definition of motivation is based on Self-Determination Theory, which posits that there are two types of motivation: intrinsic and extrinsic [29]. Intrinsic motivation is doing something or acting in a certain way due to the activity itself being inherently satisfying or enjoyable, whereas extrinsic motivation refers to doing an activity to pursue a separate outcome. Since intrinsic motivation is more powerful than extrinsic motivation to elicit the performance of a behavior, Ryan and Deci [30] studied how extrinsic motivation could be internalized to the intrinsic direction. According to their research, intrinsic motivation involves three psychological needs: competence, autonomy, and relatedness. The process of internalization goes through four steps: *external regulation*, *introjection*, *identification*, and *integration*. External regulation works through explicit external rewards, whereas in introjection, behavior is partially autonomous and based on an individual level of reinforcement, e.g. pride or shame. Identification refers to realization of the importance of the behavior towards personal values, and in integration the behavior gets aligned with other characteristics of self [30]. Therefore, in order to motivate a person to act in a certain way (e.g. consume local food), the intrinsic and extrinsic types of motivation and the gradual internalization process should be considered.

2.2 Applications for Food Consumption

Various digital technologies have been developed to assist or enhance tourism experience [24]. Many food-related applications have focused on providing meaningful information in the right context, e.g. facilitating a location-based search for a preferred type of a restaurant or enabling tourists to digitally record their food experience and memories. Recently, AR technology has begun to be combined with mobile applications, many of which are research-proposed, but some are already on the market.

Chamberlain and Griffiths [7] presented an early design of a multimedia platform called Tastebooks, a system where local people and travelers could co-create food-related content and use it to find ingredients and recipes. The system was also envisaged to provide means for food providers to highlight their local produce and present the cultural aspects of the food. The authors suggest that such a system could simultaneously be used for educating travelers regarding sustainable and responsible behavior.

Another application is FlavourCrusader, a prototype of a mobile seasonal food guide [34]. The application aimed to encourage people to buy fresh local food in order to curtail carbon emissions, boost the local community, and take care of their health. Based on an interview study, the authors identified six motivations for buying local food: connecting with food producers, supporting the local economy, improved taste and quality, health benefits, sustainability, and distrust in mainstream retailers and certification schemes. The first application prototype simply displayed a list of seasonal food items, and user evaluations suggested that food information itself was inadequate to motivate users and bring them into action. In the next iteration, relevant content was added to the list of food items, for example, related stories or recipes using the ingredients. The study suggests that food information should be integrated with other relevant information within the right context. The authors also noted that data sourcing and maintenance for food stores, prices, locality information, etc. would require significant resources, which could partially be addressed by a crowd-sourcing approach.

Thus far, the research specific to AR and food in the tourism context appears scarce. One example is Foodies, a prototype application [35] that aims to address travelers' language barriers and lack of knowledge about local foods. On the commercial side, Google

Translate [14] is an example of a MAR application that allows travelers to read information written in different languages without typing with AR; it can help tourists to understand food information in a mobile context such as restaurants or stores, as it can show translated results of food menus or ingredient names through the AR camera view. Another commercial AR solution is QReal [26] that offers e.g. a virtual 3D food menu or advertisement on the table in a restaurant using a mobile device. This application may arouse a joyful experience in addition to enhancing provided information. Overall, the applications have considered users' context information such as location and season, in which AR may work effectively. However, merely providing information about local food does not appear to be sufficient for tourists to spur into action [34].

2.3 User Experience of MAR

User experience (UX) encompasses a variety of aspects related to the users and the context of use for a product or service. Regarding AR technology, Li and Fessenden [22] argue that AR can improve user experience in three ways. First, AR can reduce the cost of accessing information by showing the relevant data or figures in the right place in the real world. Second, AR can decrease the cognitive load by reducing the effort needed to remember how to use or to find the information. Third, users can access multi-combined information easily without switching attention.

Olsson et al. [25] emphasize the importance of understanding users' expectations to establish a basic level for the overall MAR service. In a study of users' expectations, they identified central design requirements under the categories of functionality, information content, and interaction. One example of the requirements related to information content is relevance – users expect to get relevant content in a meaningful way for their situation. Furthermore, Kourouthanassis et al. [21] proposed five design implications for development of MAR applications: (1) Utilize the context information for providing content; (2) Give connectivity with the content; (3) Take care of the privacy issues related to the content; (4) Provide feedback about the objects and their moving in the real world; (5) Help the process and memory of use. With these principles, the researchers examined eight existing MAR applications and found that six of them did not meet the principles (3) and (4). This indicates that the privacy and feedback aspects can be easily overlooked when designing MAR applications.

To summarize the studies that deal with the UX of MAR, MAR has the potential to enhance user experience especially by allowing users to obtain relevant information easily. The content should be closely related to the user or their contextual information and be reliable. In addition, privacy and safety should be considered.

2.4 Summary of Related Work

Tourists have different food-related motivations, and they seek different kinds of experiences. This should be considered when designing an application for local food consumption, especially regarding what information to provide about food and how to deliver and present it. We can summarize five motivational factors for travelers' food experience from prior research: *personal*, *novel/diverse*, *familiar*, *locality-aware*, and *enjoyable*. Out of these elements, existing non-MAR applications appear to have addressed 'locality-aware' and 'novel/diverse', but 'enjoyable', 'personal' and 'familiar' have received less attention. MAR could be able to provide richer and more versatile experiences that build on these motivational factors.

3 EXPERIENCE DESIGN PROCESS

Figure 1 presents the overall experience design process in this study. In Phase 1, an initial MAR concept was created, and a user study was conducted to understand user needs and evaluate the concept. In Phase 2, an application prototype was designed iteratively, starting from experience goals. In Phase 3, the interactive prototype was evaluated with a sample of potential users.

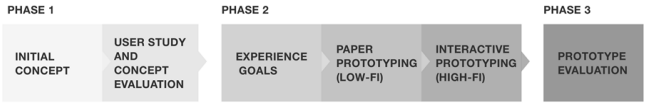

Figure 1: The Three Phases of the Experience Design Process

3.1 Initial Concept

The initial concept of the application was based on the idea of using MAR to show tourists the origins of food ingredients to encourage local food consumption. It was also inspired by Sourcemap [6], a web-based tool for visualizing supply chains of products on a map, and by its use case in which a local food chef applied Sourcemap to show customers the distances the food ingredients traveled [5].

Figure 2 presents the initial concept sketch. The blue-colored part of the sketch represents the real food item (in this case, a blueberry pie), and the black-colored parts represent the information displayed on the screen as virtual layers over the food item. The information includes food name, its main ingredients, and their origins. Thus, a tourist could place their mobile device above a real food item and see the information pop up on the screen. By moving the device upwards, the origins of the ingredients come into view.

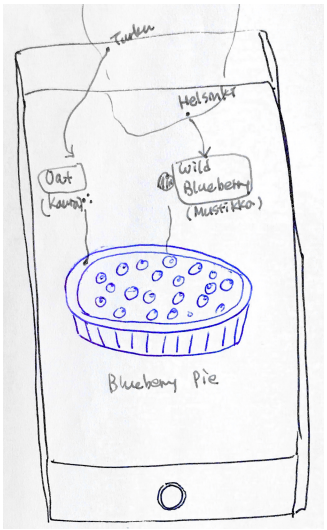

Figure 2: The Initial Application Concept Sketch

4 USER STUDY AND CONCEPT EVALUATION

After the initial concept was sketched, a user study was conducted to investigate potential users' needs and attitudes towards a MAR application for local food in a travel context. The objective of the user study was to understand how travelers consume local food in travel destinations and find out their needs for a MAR application. Two separate methods were used: (1) Observation in natural settings and (2) Interviews with initial concept evaluation.

4.1 Methods

4.1.1 Observation. Observation was carried out in natural settings (restaurants and market halls) to gain insight into tourists' actual food consumption behavior. The observation was done by one researcher at five sites in two cities in December 2018. Popular restaurants and market halls were chosen as observation locations based on their rankings in TripAdvisor and Google. Potential tourists were identified based on the language they spoke and the appearance of suitcases or large backpacks. In observation, their actions or words related to food consumption were written down. In total, 17 tourist groups were observed. A brief intercept interview was conducted with two groups. The interview questions focused on food choices, food consumption, and local food during travel.

4.1.2 Interviews and Initial Concept Evaluation. Semi-structured interviews were carried out in January 2019. The interview sessions took place in a university cafe that had a comfortable atmosphere. The participants were recruited by posting about the study in two Facebook community groups aimed at foreigners living in the city or visiting it. Seven people (three male and four female) participated in the interview. Six were between 20-29 years old, and one was between 50-59 years old. All were of foreign nationality, from six different countries. The interviews focused on local food experiences during travel, and additionally, initial concept evaluation was done at the end of the interview. Each session lasted 40-60 minutes: 30-40 minutes for the interview and 10-20 minutes for the initial concept evaluation. The interview began with a brief introduction of the study and obtaining consent from the participant, after which the participant filled a simple background form including questions about age, gender, nationality, traveling frequency, local food consumption and primary sources for food information. Then, the participant was asked to tell about a recent trip to warm them up to the topic. The semi-structured interview included questions about the participant's overall food experiences while traveling, food-related activities before/during/after travel, and perceptions of local food during travel. Interviews were audio-recorded. After the interview, the initial concept sketch (Figure 2) was introduced to the participant on paper, and the idea was explained. The participant was asked to tell their first impressions on the concept, perceptions of its usefulness, and give free feedback.

4.2 Analysis

Three kinds of qualitative data were collected: (1) Observation notes, (2) Interview notes, and (3) Concept evaluation notes. The observation and interview notes were analyzed through content analysis method [10]. The concept evaluation notes were sorted out for further ideation by grouping the answer notes.

4.3 Results

4.3.1 User Needs. Based on the observation and interview data, three main themes were identified regarding user needs for a local food consumption application:

(1) Locality-aware (*desire to experience local food within the cultural context*): Many participants perceived food as a part of the local culture in the travel destination. Everyone wanted to try local or special foods in the destination, although food was not a top priority for all. Four participants explicitly referred to wanting to be aware of and experience the culture.
(2) Information (*efforts to find out and refine food information*): Participants often looked for food information or planned a specific restaurant or market before purchasing and consuming their food. They obtained information mainly from online sources such as Google or TripAdvisor, or from friends. Notably, suggestions from friends and local people seemed to be considered as reliable sources. Language was regarded as a challenge in food consumption in the destination.
(3) Choice (*individual considerations to plan/choose the food during travel*): The choice of a food or a place to eat often depended on participants' context, such as weather, current location, the smell on the street, or visual attractions. Two participants mentioned individual factors such as vegetarian diet and preference for certain foods that could significantly affect their food consumption in travel destinations.

4.3.2 Concept Evaluation Findings. In the initial concept evaluation, all seven participants responded positively to the goal of promoting local food and seemed excited, e.g. "I think it will be helpful. I want to know the ingredients and where the ingredients come from. " (Male, 28). "I like it. I think that's actually very good idea. [...] The trend right now is 'eat local and eat good food' and people are getting more and more conscious about it." (Female, 52). Hence, the basic concept idea was deemed appropriate to be developed further. In addition, the feedback participants gave about the concept complemented the findings about user needs:

(1) Locality-aware: Participants wanted *additional interesting food-related content* such as stories or its specialty status: "Maybe fun facts, trivia about food. Like how many people consume blueberry in the country?" (Female, 27). "If the food has special or rare ingredients and the application shows, then it would make me wow! 'wow, this is so rare and now I am eating it"' (Male, 28).
(2) Information: Participants expressed the need to *acquire food information before they eat*. "Usually, as a tourist, I look at the menu before arriving. If I have an app and put the camera on the menu and touch, highlight it and then immediately I go to Google and search what kind of ingredients, what looks like?" (Male, 26). One was also interested in tracking food supply chains: "From origin country of the food to the shipment, packaging. It takes so much energy. And as I know at least in Europe, every food is trackable." (Female, 52).
(3) Choice: The desire for *personalized content* was apparent, e.g. "Provide suggestions to the restaurant that if you like other berries, then you can tell the restaurant that the user may prefer more this berries..." (Female, 25). "Maybe if you

have historical data of the user, then you would know the preference of the user, and then you can recommend similar or taste for example? Sweet, Sour..." (Female, 29).

4.4 Design Implications

Based on the results of the user study, the following implications were drawn for the design of the application.

- *Present local food in a cultural context.* Discovery and consumption of local food should be memorable and enjoyable, and the design should take into account local cultural elements (e.g., stories of origin, ingredients, cooking).
- *Provide easy access to food-related information.* The information should be provided in tourist's own language or in English. Social information such as ratings or recommendations from other travelers or local people should be available.
- *Personalize for context and user preferences.* The application should react to contextual factors such as weather, location, and visual or olfactory cues. Personal user attributes should be considered, e.g., location, price, taste preference, and health concerns. The user's interests and motivations related to local food should also be taken into account.

5 "LOCAL FOODIE" PROTOTYPE DESIGN

The prototype design phase involved three steps (see also Figure 1): experience goals, paper prototyping, and interactive prototyping. First, experience goals were set based on the user study findings and related work. Second, a paper prototype was created based on the experience goals and design implications and tested with users in two iterations. Finally, an interactive prototype was implemented, reflecting improvements from the paper prototype testing.

5.1 Experience Goals

Experience goals are a means to formulate user experience requirements for the design of interactive systems [32]. They can serve as a guiding light in deciding what kind of product should be developed, especially in early design phases. Kaasinen et al. [19] have identified five sources of inspiration for experience goals: brand, theory, empathy, technology, and vision. Brand and vision were not applicable sources in this study, since 'brand' is based on company image and 'vision' relates to renewal of an existing product [19]. We applied the three remaining sources to identify experience elements appropriate for the application, as presented in the following.

Theory (related studies of motivation):

- Activation: feeling of being stimulated by a new task and rewards (extrinsic motivation)
- Engagement: feeling of relatedness and commitment for a task (internalization towards intrinsic motivation)
- Self-determination: feeling of free will to choose or do something (intrinsic motivation)

Empathy (user study):

- Joy of new experience: users' desire to explore new food experiences in the destination (locality-aware)
- Control in unfamiliar places: users' ability to find information by themselves to experience new food positively under their control in a new environment (information)
- Personalized: suggestions or recommendations relevant to users' background and preferences (choice)

Technology (related studies of MAR; initial concept evaluation):

- Inspiration: feeling of excitement from new objects or ideas
- Increased perception: awareness of objects in the real world and immediate responses in the environment
- Accomplishment: feeling smart and achieving by completing a task or reaching a goal easily and efficiently

Based on these nine experience elements, we established three high-level experience goals as *Adventure*, *Autonomy*, and *Competence* (Figure 3). These goals served as a guiding light and basis for the design and evaluation process of the Local Foodie application.

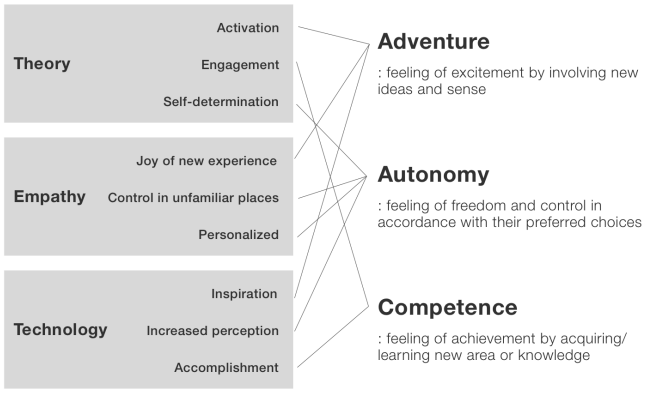

Figure 3: Experience Goals for the Local Foodie Application

Since the final experience goals involved the actions of exploring, selecting, and achieving new information, we also used gamification techniques in the design to meet the goals. Gamification means using game-like elements in systems other than games with the aim to boost user experience and user engagement [8]. Game-like elements can induce people to pay attention and maintain motivation [33]. The studies regarding gamification design [31, 33] have suggested various gameful characteristics that can be used to meet psychological needs of autonomy, competence, and relatedness, e.g. free options, challenging tasks, or social interaction. Cognitive and emotional perspectives have also been used as a basis for game elements, for example, logical goals and feedback (cognitive) and positive stories (emotional). Notably, a game-like experience can evoke pleasant emotions, which contributes to overall positive experience with a system.

5.2 Paper Prototyping

The first paper prototype was created with paper and transparent plastic films. Three key screens were designed: food information (AR view), ratings (AR view), and personal insights. The aim was to address the *adventure* experience goal by allowing the user to explore local food information and other tourists' opinions; *autonomy* goal by providing the user access to the relevant information easily; and *competence* goal by showing the user's personal progress.

The first prototype was tested with three participants (two UX experts and one international student). At the beginning of the user

test, a researcher introduced the application shortly and explained the context of use to the participant. The participant was seated at a table where a real food item was placed. The researcher gave the paper prototype to the participant and asked them to start to interact with buttons and other visual elements. The researcher facilitated the interaction by changing the interface elements. Observation notes were written about problems or particular behavior, e.g. "looks confused with the ingredient visuals" or "tapped the 'recipes' button; interested?". After testing, a post-interview was conducted about overall feelings and perceptions, interaction, information content, game elements, and free comments.

Based on the results of the first test, a second paper prototype version was created (Figure 4). Due to the participants' positive overall reaction, the second version sustained the same three screens. More details and game elements were added and usability problems were fixed. The contents of the prototype are explained below.

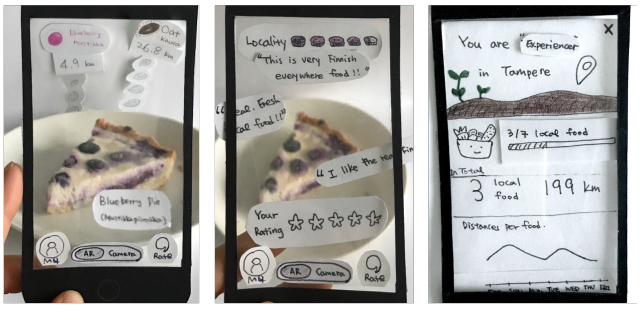

Figure 4: Paper Prototype Design, Second Iteration

(1) Food information (Figure 4, left): The user can access food information by scanning a real food item or a food image with the MAR application. Virtual food information (name, ingredients, and distances to ingredients' origins) appears as a layer on the real food in native and English languages. When exploring detailed food information, the user can collect specific elements (local food, ingredients). All three experience goals are targeted: selecting the food/ingredients the user wants to know about (autonomy); exploring new visuals and discovering food origins (adventure); and learning of and collecting the new local food/ingredients (competence).
(2) Food ratings (Figure 4, center): The user can learn about the local food by checking its locality score and exploring the ratings and comments of other users, while having the real food item visible underneath. Locality scores, ratings and comments aim to provide the user an experience of autonomy through a better opportunity to make an informed decision about the food, and the new way of exploring information aims to evoke an experience of adventure.
(3) Personal insights (Figure 4, right): The user can view personal insights about their context and their achievements related to local food consumption – the location they are traveling, the number of local foods consumed, the accumulated distance of the foods' main ingredients, and the history of the foods they have consumed. The performance and progress graphs are linked to the experience goal of competence, aiming to provide the user the feeling of achievement.

The second prototype was tested with five participants (two UX experts and three international students) following the same procedure as the first user test. The results of the two user tests provided several implications for the design of an interactive prototype:

- *Simplified visuals and interactions in the AR view (autonomy).* Visual elements and interaction modes should be simple and easy to perceive to reduce distractions and cognitive load (e.g. simple tap gesture, fewer visual elements at a time).
- *Game-like elements appeal to users (competence, adventure).* Immediate feedback and progress levels can motivate users to take the next action towards local food consumption. Used phrases also affect users' emotions, e.g. positively worded story-like expressions for level names can evoke feelings of adventure and accomplishment.
- *Personalized information increases motivation (autonomy).* Users feel control of themselves by checking their status, e.g. their location or personal food consumption history.
- *Social relatedness by giving/receiving comments encourages users to do more actions (autonomy, competence).* Particularly, if the other users have the same background or context, the motivation might be stronger.

5.3 Interactive Prototyping

Based on the results of paper prototyping, an interactive prototype of the Local Foodie application was created with the Torch prototyping tool [18] on iPhone 7 running iOS 12.2. At the time of the study, Torch was available in AppStore and required iOS version 11.3 or later and iPhone 6S or later, or iPad.

Figure 5 presents the prototype's main user flow with screens. First, the user starts to scan the food to discover information about it. The application identifies the food and displays its name and ingredients to the user (Figure 5, top left), visualizing the distances from the ingredients' production places. Second, the user can explore detailed information about an ingredient, such as local/cultural stories related to the food, by tapping the labels to view information and collect the ingredients (Figure 5, top center). Third, the user levels up after consuming a required amount of local foods and is encouraged to try more local food to reach the next level (Figure 5, top right). Fourth, the user can rate the food and see other users' comments (Figure 5, bottom left). Last, the user can check the personal insights page for the overall statistics and current progress such as level, distances the consumed foods have travelled, and food consumption history (Figure 5, bottom center and right).

6 PROTOTYPE EVALUATION

The interactive prototype was evaluated with ten participants in April 2019 in a public open kitchen at the university. This open space was chosen since it resembled a real food consumption context and allowed participants to feel comfortable. The evaluation methods were observation and think-aloud during prototype testing, and a post-questionnaire and semi-structured interview after the test. The purpose of the evaluation was to verify if the design fulfilled the experience goals set in the previous phase, and thus gather further insight on design implications for MAR for local food.

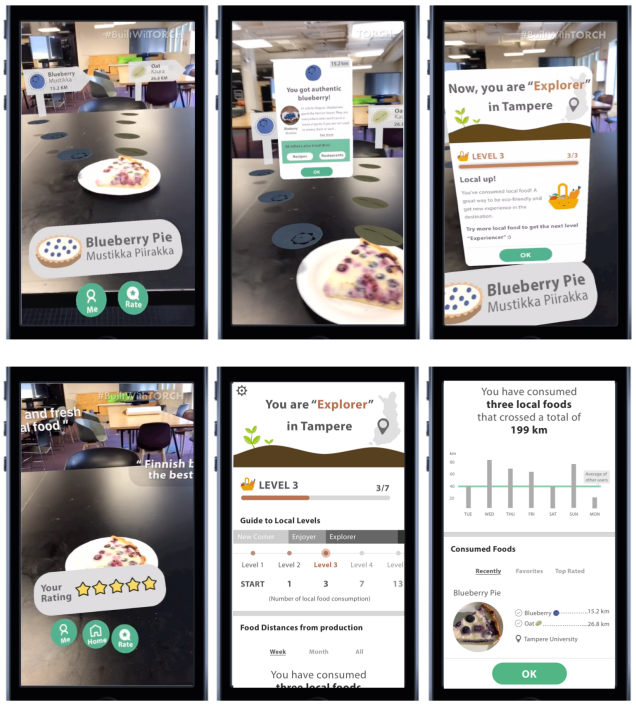

Figure 5: Interactive Prototype Design

6.1 Participants

Ten participants (7 male, 3 female) were recruited for the evaluation. Three of them had also participated in the initial user study, and two had tested the paper prototype. Five participants were newly recruited from a group of international students of the university. Nine participants were 20-29 years old, and one was 30-39 years old. All were of foreign nationality, from eight different countries.

6.2 Procedure

The evaluation was conducted in April 2019, and the evaluation session consisted of: introduction; an explanation for the purpose and procedure of the test; consent to record the test; filling the background form; think-aloud introduction and practice; user testing during which the participant interacted with the interactive prototype; post-test questionnaire; and post-interview.

6.2.1 User Testing. During the test, the participant was instructed to speak out (think-aloud) their thoughts and feelings while interacting with the prototype. A researcher asked the participant to perform several tasks in line with the user flow presented in Figure 5. The researcher facilitated the procedure by reminding the participant to 'think aloud' but not otherwise answering their questions or interfering with their actions. The participant's behavior and interaction with the application were video-recorded.

6.2.2 Post-Questionnaire. After testing the prototype, the participant was asked to fill in a questionnaire which was a modified version of Intrinsic Motivation Inventory (IMI) [13]. IMI has been developed to measure human's motivation for experience [29], and it consists of seven subscales. For this study, we chose the subscales 'Interest/Enjoyment' and 'Value/Usefulness', and modified them to refer to 'app use' or 'local food consumption' instead of 'activity' as in the original scale. These two subscales were chosen to assess if using the designed prototype was intrinsically motivating and if it could encourage participants to consume local food. The 'Interest/Enjoyment' subscale was taken to measure the level of intrinsic motivation in application use, and the 'Value/Usefulness' subscale to measure how much potential the application would have for use in real context, in terms of how valuable or useful participants considered it to be. Table 1 shows the statements under the two selected subscales. The responses to the statements are given on a 7-point Likert scale, from 1 ('not at all true') to 7 ('very true').

Table 1: Intrinsic Motivation Inventory Subscales in the Post-Questionnaire

Interest/Enjoyment	Value/Usefulness
I enjoyed using the app very much.	I believe using the app could be of some value to me.
Using the app was fun to do.	I think that using the app is useful for local food consumption when I travel.
I thought using the app was boring. (R)	I think this is important to do because it can motivate me to consume local food.
Using the app did not hold my attention at all. (R)	I would be willing to use the app again because it has some value to me.
I would describe using the app as very interesting.	I think using the app could help me consume local food.
I thought using the app was quite enjoyable.	I believe using the app could be beneficial to me.
While I was using the app, I was thinking about how much I enjoyed it.	I think using the app is important.

(R) denotes a reversal of the item when calculating the score.

6.2.3 Post-Interview. The post-interview was semi-structured and had four different themes: overall perception and feelings, AR interaction, information, and game elements and motivation. The participant was also asked to provide comments and suggestions at the end of the interview. The interview was recorded.

6.3 Analysis

Four kinds of data were collected from the final user evaluation: (1) Observation notes: the written notes of observations during user testing; (2) Think-aloud quotes: transcribed text data obtained from video recordings of user testing; (3) Post-interview quotes: transcribed text data obtained from recorded post-interview; (4) Post-questionnaire answers: completed IMI scales. The qualitative data consisted of 13 observation notes, 60 think-aloud quotes, and 107 interview quotes.

6.3.1 Experience Goals. To evaluate the fulfillment of experience goals, the qualitative data were analyzed with deductive content

analysis method. Deductive content analysis is used when a category is already established by a theory, model, concept, or prior study [9]. The three experience goals set for the Local Foodie application (adventure, autonomy, competence) were used as a classification frame in the analysis, and the data were coded accordingly. If a data item did not fall under any of the three experience goals, it was coded under 'other'. In addition, each data item was coded as positive, negative, or neutral to reflect the participant's attitude.

6.3.2 Intrinsic Motivation. To evaluate the motivation related to the application use, the quantitative data from the post-questionnaire was analyzed by first calculating the scores of the two subscales of IMI (Interest/Enjoyment and Value/Usefulness) for each participant. Then, the mean and standard deviation (SD) was calculated for both subscales. To identify motivational factors, the qualitative data was analyzed with deductive content analysis, using Interest/Enjoyment and Value/Usefulness as a classification frame in the analysis.

6.4 Results

6.4.1 Experience Goals. Table 2 presents the occurrences of items related to each experience goal and their valence (positive, negative, neutral). The 'Other' category included items such as general evaluations of the overall concept, additional ideas, battery concerns, and limitations of the use of the mobile device.

Table 2: Occurrences of Adventure, Autonomy and Competence Experiences

	Positive	Negative	Neutral	Total
Adventure	41 (73.2%)	2 (3.6%)	11 (19.6%)	56
Autonomy	41 (69.5%)	16 (27.1%)	2 (3.4%)	59
Competence	25 (83.3%)	3 (10.0%)	2 (6.7%)	30
Other	10 (90.9%)	1 (9.1%)	2 (18.2%)	11

Adventure and autonomy related experiences were more common than competence. The experiences were mostly classified as positive. For example, related to adventure, participants expressed curiosity and excitement about accessing new information with MAR, e.g. "It looks so awesome! The graphics and AR things! I wanted to touch" (Male, 28). They also wanted to explore more, e.g. "I would like to see the recipes!" (Female, 27). As for autonomy experience, participants enjoyed being able to control the application's contents, e.g. "I can keep track of what I have done before!" (Male, 22). Related to competence, participants appeared to feel excited and motivated when they reached a new level or got new items, for example, "I need more higher level! I got interested in the level!" (Male, 31), and "I felt excited when I move on the next level!" (Female, 27). Regarding autonomy, 27.1% of the findings were negative. The main reason for this appeared to be the difficulty in controlling the ingredient information, which was located some distance away from the real food in the AR view.

6.4.2 Intrinsic Motivation. The prototype was rated high regarding its Interest/Enjoyment and Value/Usefulness: the mean scores of the subscales were 6.23 (SD = 0.46) and 5.77 (SD = 0.40) respectively on a seven-point scale. While the values were high enough to demonstrate that the application motivates users, the score of Value/Usefulness was lower than that of Interest/Enjoyment. We identified three specific factors related to Interest/Enjoyment:

- *Playful or gamified content:* Game elements such as levels or stories, e.g. "I am interested in my level and level-up, which motivates me." (Male, 26)
- *Enjoyable MAR interaction:* Pleasure from moving AR screens to explore and interact with various visual elements or animations, e.g. "Something caught my attention like pictures are following my movements." (Male, 22), "It would be interesting also to maybe for example, add a little animation to level up." (Female, 27)
- *Social Relatedness:* Social information or actions during application use can enhance enjoyment, e.g. "Oh the comments! Interesting!" (Male, 26), "When I find something then I may select and share with my friends?" (Female, 27)

Related to Value/Usefulness, four factors were identified:

- *External/internal benefits:* A mix of external/internal rewards to increase the long-term usefulness and the possibility to internalize users' motivation, e.g. "If I get many ingredients, then I get discount? It would be good" (Male, 26), "More to know how local usefulness ... And pay more attention to my nutrient better. Healthy..." (Male, 28)
- *Individual consideration:* Personal approach based on personal preferences, e.g. specific diet or allergens to avoid: "One thing came into my mind! Beef and vegan thing. It could have some suggestions." (Female, 25)
- *AR app tutorial:* A short AR app introduction or guide could contribute to usefulness, e.g. using a virtual coach or a walkthrough: "I didn't use AR application [before]. So at first I was confused a bit." (Female, 25)
- *Relevant information:* Easily and immediately accessible food information, e.g. "Nice it's quite handy. I can also get more information about recipes and restaurants." (Male, 26)

7 DISCUSSION

This study aimed to investigate how MAR technology could be used to encourage tourists to consume local food. The first research question *"What needs do tourists have for a local food consumption application?"* was addressed with a user study and a review or related research. The primary needs identified for a local food consumption application were desire to experience local food in the cultural context (*locality-aware*), need to acquire *information* about food before consumption decision, and ability to *choose* specific local foods based on personal or contextual factors. Reflecting prior research of tourists' motivations [3, 17], the participants in our studies were primarily interested in food origins due to interest in new experiences or local culture, less due to sustainability.

The second research question, *"What kinds of experiences can be designed for tourists' local food consumption using a MAR application?"*, was approached by using theory, empathy and technology as sources of inspiration for possible experience goals. The experience goals set for the Local Foodie application prototype were adventure, autonomy, and competence. The prototype evaluation resulted in fairly high interest/enjoyment and value/usefulness scores, which indicates that using the prototype was intrinsically motivating for

the participants. The participants' experiences were especially positive related to adventure and competence experience goals, and autonomy was also supported. Fulfillment of autonomy and competence has been shown to boost intrinsic motivation [29], and thus we can assume that the high motivation level was in particular associated with food information and personal insights design elements that addressed these experience goals. Moreover, social relatedness is another high-level experience goal to consider in future work, as our findings indicate that local food recommendations from friends or locals could be perceived as especially reliable.

Achieving the ultimate goal of the Local Foodie application, i.e. encouraging tourists to increase local food consumption while traveling, would require further development and research. Our findings thus far suggest that the MAR approach in itself has potential to engage people to try out the application in short-term. The main benefits of MAR manifested in the ease of information processing and the enrichment of provided information. The sense of adventure was evident in participants when they were navigating the MAR view with physical motions. Hence, the use of the application may address the same experiential factors 'novel/diverse' and 'enjoyable' that prior research has found to influence tourists' food consumption choices [20, 23]. In addition, the 'locality-aware' factor was emphasized in our MAR prototype through the visualization of distances the food ingredients had traveled. Based on our findings, we address our third research question *"What are the design implications for MAR applications for local food consumption?"* by proposing three design implications, presented in Table 3.

Table 3: Design Implications for MAR Applications to Encourage Tourists to Consume Local Food

Design Implication	Description
Exploration of food origins	Create an experience of adventure when learning about origins of food, e.g. through navigating distances with MAR. Present local food in a cultural context.
Awareness of context and preferences	Personalize for the user's context and preferences to create an experience of autonomy.
Local food as an accomplishment	Provide positive feedback through MAR view and frame local food consumption as a positive accomplishment to create an experience of competence.

The importance of utilizing context information has come up in prior research both related to tourists' food choices [20, 23] and to the user experience of MAR [21]. Our study also identified context-awareness and personalization for tourists' preferences as a design implication for an application aiming to encourage local food consumption. However, these factors were not yet included in the Local Foodie prototype beyond displaying the user's location and personal progress. In future work, context-awareness and personalization could be leveraged by providing suggestions based on e.g. micro-location information to find nearby restaurants that serve local foods, personal preferences such as diet and preference towards new or familiar foods, and other users with similar profiles.

Regarding MAR interaction, a usability issue that negatively affected autonomy experience was raised in the prototype evaluation. Users had difficulty to elicit the next actions when the digital visuals on the screen were far from the user or not discoverable due to similar color or high transparency. Hence, the distances and design elements should be studied and tested with users to design further digital visuals and triggers. In this study, the interaction and gestures were quite simple and focused on visual feedback. The MAR user experience could be enhanced if other sensory feedback (haptic or auditory) or multimodal interaction was added.

While the general concept of the Local Foodie application was acceptable and attractive to the participants in our study, there are still challenges in its technological feasibility. Reliable recognition of food based on visual information only is a major issue, and hence a combination of image processing, location data and information about restaurant menus or market products would be required [16] to make food recognition easy and accurate for users. However, the image recognition algorithms are constantly being improved e.g. with deep learning. Currently, several applications such as Foodai [12] and Calorie Mama [2] that are already on the market are capable of showing food type and calories based on image information alone, although they do not yet utilize AR. Furthermore, collecting the information about food ingredients and their origins would require restaurants, cafeterias and other food vendors to acquire the information from producers and input it into the system. This challenge has also been noted by Young and Hagen [34]. Reducing the language barrier that tourists encounter may be an easier challenge to overcome, as menus and labels written in local language could be recognized with AR and translated for the user.

Finally, while this study focused on tourists, local people may also have a need for a food-related application to make sustainable choices in their daily lives. In addition, market vendors or restaurant owners are crucial stakeholders as information providers for such an application. Future work should involve these stakeholders to develop a truly valuable application for local food consumption.

7.1 Limitations

The findings of this study have to be interpreted in the light of its limitations. The sample size was relatively small, with seven people participating in the interviews during the user study, and ten people in the final evaluation. The observation in the user study was carried out in natural settings, but most of the participants in the interviews and the prototype evaluation were international students at the university. Thus, the findings have limited generalizability to tourists during travel. Moreover, the evaluation sessions were not conducted in a real context, although the location resembled an actual food consumption place. Conducting interviews with a more heterogeneous and culturally diverse sample of participants, including tourists visiting the city, could have revealed additional experience goals and design implications.

In terms of methodology, the IMI subscales that were used to measure intrinsic motivation (Interest/Enjoyment) and potential for internalization (Value/Usefulness) had no clear reference values. The IMI scales were not used in earlier iteration rounds in the design process, so we cannot determine which specific design elements were associated with high intrinsic motivation.

8 CONCLUSIONS

While sustainability is not a priority for all tourists during traveling, they could be motivated to consume local, sustainably produced food if it provides them positive and memorable experiences. The main goal of this study was to identify the essential elements of a MAR application that could encourage tourists to consume local food. MAR was chosen due to its demonstrated potential in providing engaging experiences for tourists [21]. Through experience design, we identified adventure, autonomy, and competence as high-level experience goals for the "Local Foodie" application. The findings suggest that using AR on a mobile device provides a sense of adventure and autonomy, as it gives the user freedom to explore, and in the context of local food, the visualization of ingredients' origins makes the information easy to process. Future work should investigate further the opportunities to utilize context-awareness and personalization in MAR for local food consumption.

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REFERENCES

[1] Tommy D. Andersson, Lena Mossberg, and Anette Therkelsen. 2017. Food and tourism synergies: perspectives on consumption, production and destination development. *Scandinavian Journal of Hospitality and Tourism* 17, 1 (Jan. 2017), 1–8. https://doi.org/10.1080/15022250.2016.1275290

[2] Azumio. [n. d.]. Calorie Mama Food AI - Food Image Recognition and Calorie Counter using Deep Learning. Retrieved October 26, 2019 from https://www.caloriemama.ai/

[3] Peter Björk and Hannele Kauppinen-Räisänen. 2014. Culinary-gastronomic tourism – a search for local food experiences. *Nutrition Food Science* 44, 4 (July 2014), 294–309. https://doi.org/10.1108/NFS-12-2013-0142

[4] Peter Björk and Hannele Kauppinen-Räisänen. 2016. Local food: a source for destination attraction. *International Journal of Contemporary Hospitality Management* 28, 1 (Jan. 2016), 177–194. https://doi.org/10.1108/ijchm-05-2014-0214

[5] Leo Bonanni. 2011. Sourcemap. *XRDS: Crossroads, The ACM Magazine for Students* 17, 4 (June 2011), 22. https://doi.org/10.1145/1961678.1961681

[6] Leonardo Bonanni, Matthew Hockenberry, David Zwarg, Chris Csikszentmihalyi, and Hiroshi Ishii. 2010. Small Business Applications of Sourcemap: A Web Tool for Sustainable Design and Supply Chain Transparency. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10)*. ACM, New York, NY, USA, 937–946. https://doi.org/10.1145/1753326.1753465

[7] Alan Chamberlain and Chloe Griffiths. 2013. Taste and Place: Design, HCI, Location and Food. In *Proceedings of the 5th International Workshop on Multimedia for Cooking & Eating Activities (CEA '13)*. ACM, New York, NY, USA, 57–62. https://doi.org/10.1145/2506023.2506034

[8] Sebastian Deterding, Miguel Sicart, Lennart Nacke, Kenton O'Hara, and Dan Dixon. 2011. Gamification. using game-design elements in non-gaming contexts. In *Proceedings of the 2011 annual conference extended abstracts on Human factors in computing systems - CHI EA '11*. ACM Press. https://doi.org/10.1145/1979742.1979575

[9] Satu Elo and Helvi Kyngäs. 2008. The qualitative content analysis process. *Journal of Advanced Nursing* 62, 1 (April 2008), 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

[10] Christen Erlingsson and Petra Brysiewicz. 2017. A hands-on guide to doing content analysis. *African Journal of Emergency Medicine* 7, 3 (2017), 93 – 99. https://doi.org/10.1016/j.afjem.2017.08.001

[11] Visit Finland. [n. d.]. Statistics Service Rudolf: Tourism in Finland. Retrieved August 29, 2019 from http://visitfinland.stat.fi/PXWeb/pxweb/en/VisitFinland/VisitFinland__Matkailutilinpito/040_matp_tau_104_fien.px/table/tableViewLayout1/?rxid=33e086d6-0449-4114-875f-48f9fa797db1

[12] Foodai. [n. d.]. Foodai - State-of-the-art food image recognition technologies. Retrieved October 26, 2019 from https://foodai.org/

[13] Center for Self-Determination Theory. [n. d.]. Intrinsic Motivation Inventory (IMI). Retrieved August 29, 2019 from https://selfdeterminationtheory.org/intrinsic-motivation-inventory

[14] Google. [n. d.]. Google Translate. Retrieved August 29, 2019 from https://translate.google.com/intl/en/about

[15] Marc Hassenzahl, Kai Eckoldt, Sarah Diefenbach, Matthias Laschke, Eva Lenz, and Joonhwan Kim. 2013. Designing Moments of Meaning and Pleasure - Experience Design and Happiness. *International Journal of Design* 7, 3 (2013), 21–31. http://www.ijdesign.org/index.php/IJDesign/article/view/1480

[16] Luis Herranz, Shuqiang Jiang, and Ruihan Xu. 2017. Modeling Restaurant Context for Food Recognition. *IEEE Transactions on Multimedia* 19, 2 (Feb. 2017), 430–440. https://doi.org/10.1109/tmm.2016.2614861

[17] Anne-Mette Hjalager and Pia Heike Johansen. 2013. Food tourism in protected areas – sustainability for producers, the environment and tourism? *Journal of Sustainable Tourism* 21, 3 (2013), 417–433. https://doi.org/10.1080/09669582.2012.708041 arXiv:https://doi.org/10.1080/09669582.2012.708041

[18] Torch 3D Inc. [n. d.]. Torch AR prototyping app. Retrieved August 29, 2019 from https://www.torch.app/

[19] Eija Kaasinen, Virpi Roto, Jaakko Hakulinen, Tomi Heimonen, Jussi P. P. Jokinen, Hannu Karvonen, Tuuli Keskinen, Hanna Koskinen, Yichen Lu, Pertti Saariluoma, Helena Tokkonen, and Markku Turunen. 2015. Defining user experience goals to guide the design of industrial systems. *Behaviour & Information Technology* 34, 10 (2015), 976–991. https://doi.org/10.1080/0144929X.2015.1035335 arXiv:https://doi.org/10.1080/0144929X.2015.1035335

[20] Yeong Gug Kim, Anita Eves, and Caroline Scarles. 2009. Building a model of local food consumption on trips and holidays: A grounded theory approach. *International Journal of Hospitality Management* 28, 3 (2009), 423 – 431. https://doi.org/10.1016/j.ijhm.2008.11.005

[21] Panos Kourouthanassis, Costas Boletsis, Cleopatra Bardaki, and Dimitra Chasanidou. 2015. Tourists responses to mobile augmented reality travel guides: The role of emotions on adoption behavior. *Pervasive and Mobile Computing* 18 (April 2015), 71–87. https://doi.org/10.1016/j.pmcj.2014.08.009

[22] Angie Li and Therese Fessenden. 2016. Augmented Reality: What Does It Mean for UX? Retrieved August 29, 2019 from https://www.nngroup.com/articles/augmented-reality-ux/

[23] Athena H.N. Mak, Margaret Lumbers, Anita Eves, and Richard C.Y. Chang. 2012. Factors influencing tourist food consumption. *International Journal of Hospitality Management* 31, 3 (2012), 928 – 936. https://doi.org/10.1016/j.ijhm.2011.10.012

[24] Barbara Neuhofer, Dimitrios Buhalis, and Adele Ladkin. 2013. A Typology of Technology-Enhanced Tourism Experiences. *International Journal of Tourism Research* 16, 4 (July 2013), 340–350. https://doi.org/10.1002/jtr.1958

[25] Thomas Olsson, Else Lagerstam, Tuula Kärkkäinen, and Kaisa Väänänen-Vainio-Mattila. 2011. Expected user experience of mobile augmented reality services: a user study in the context of shopping centres. *Personal and Ubiquitous Computing* 17, 2 (Dec. 2011), 287–304. https://doi.org/10.1007/s00779-011-0494-x

[26] QReal. [n. d.]. QReal – AR for the Real World. Retrieved August 29, 2019 from https://qreal.io/

[27] Elizabeth Randall and Diva Sanjur. 1981. Food preferences - their conceptualization and relationship to consumption. *Ecology of Food and Nutrition* 11, 3 (1981), 151–161. https://doi.org/10.1080/03670244.1981.9990671 arXiv:https://doi.org/10.1080/03670244.1981.9990671

[28] Greg Richards. 2012. Food and the tourism experience: major findings and policy orientations. In *Food and the Tourism Experience*, D. Dodd (Ed.). OECD, Paris, 13–46.

[29] Richard M. Ryan and Edward L. Deci. 2000. Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology* 25, 1 (Jan. 2000), 54–67. https://doi.org/10.1006/ceps.1999.1020

[30] Richard M. Ryan and Edward L. Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist* 55, 1 (2000), 68–78. https://doi.org/10.1037/0003-066x.55.1.68

[31] Michael Sailer, Jan Hense, Heinz Mandl, and Markus Klevers. 2013. Psychological Perspectives on Motivation through Gamification. *Interaction Design and Architecture(s) Journal* 19 (2013), 28–37.

[32] Heli Väätäjä, Paula Savioja, Virpi Roto, Thomas Olsson, and Jari Varsaluoma. 2015. User experience goals as a guiding light in design and development – Early findings. In *INTERACT 2015 Adjunct proceedings*. University of Bamberg Press, 521–527.

[33] Steffen P. Walz, Sebastian Deterding, Lori Andrews, Buster Benson, Ian Bogost, John M. Carroll, Mary Flanagan, Bernard De Koven, and Cliff Lampe. 2015. *Gameful World: Approaches, Issues, Applications*. MIT Press, Cambridge. http://ebookcentral.proquest.com/lib/tampere/detail.action?docID=3339935 ID: 3339935.

[34] Grant Young and Penny Hagen. 2014. Encouraging Fresh Food Choices with Mobile and Social Technologies: Learning from the FlavourCrusader Project. In *Eat, Cook, Grow: Mixing Human-Computer Interactions with Human-Food Interactions*, Jaz Hee jeong Choi, Marcus Foth, and Greg Hearn (Eds.). MITP. https://ieeexplore.ieee.org/document/6786543

[35] Yue Yuan. 2018. Augmenting Food Experience While Traveling Abroad by Using Mobile Augmented Reality Application. In *Cross-Cultural Design. Methods, Tools, and Users*, Pei-Luen Patrick Rau (Ed.). Springer International Publishing, Cham, 259–268.

[36] John Zimmerman, Jodi Forlizzi, and Shelley Evenson. 2007. Research through Design as a Method for Interaction Design Research in HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '07)*. Association for Computing Machinery, New York, NY, USA, 493–502. https://doi.org/10.1145/1240624.1240704