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Situated learning Opportunities in Direct Agri-Food Chains: the Role of Mobile-Based Services

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Abstract

Direct Agri-food Chains (DAFCs) give consumers several learning opportunities (SLOs) as they enable continuous direct interactions and knowledge exchange with food producers. It is a form of consumer empowerment since consumers make more informed choices in their consumption process. The phenomenon can be amplified by the introduction of mobile-based services that offer the opportunity to access to more food information and the capability to exchange information and opinion with peers. Despite the emerging importance of learning interaction in food related settings, little research has been devoted to study situated learning in alternative agri-food networks under an organizational perspective. Moreover, few works addressed the role of mobile application in SLOs for food consumers. This work aims to address the following research questions: How learning opportunities for consumers occur in DAFCs? Could they be enhanced through the employment of mobiquitous services? This paper attempts to answer these questions proposing a framework to assess the offering of app-based services supporting food knowledge acquisition for consumers, with a specific focus on situated learning opportunities (SLOs) arising in DAFCs organizational practices.

Keywords: Situated Learning; Mobile Apps; Direct Agri-Food Chains; Food.

1. Introduction

Agri-food sector have been invested by significant changes both on companies' and consumers' sides. From a company perspective, small and medium enterprises in the agri-food sector have been facing several challenges. Agri-food companies are subjected to a continuous imbalance of their bargaining power; they suffer cost-price squeeze, unfair contractual agreement, rising production costs and declining commodity prices that reduce their profitability [1,2,3]. The Agri-food systems are controlled by few large farmers, multinational manufacturers, and big distributors.

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This caused a loss of decisional power for local farmers and producers and to the crisis of confidence in mass-produced, 'placeless and faceless' food products, as well as the 'crisis of trust' among consumers [4,1].

First efforts to overcome limits of mainstream agri-food systems are noticed since the nineties, when farmers, and other people or organizations dealing with agricultural and rural issues, have started organizing themselves spontaneously in order to solve their problems and those of rural communities. Farming has been diversified through the valorization of local resources, assuming a more multifunctional role and increasingly integrating into the rural context. New networks of farmers and consumers have been modified the pre-existent relationships among the actors.

Recently, scholars are helping farmers to develop new and alternative business models able to guarantee competitive advantages, to improve farm revenue streams, to return in taking an active role in the agri-food system, and to develop new consumer market niches [5]. With this aim, different forms of collaborative networks (referred as alternative agri-food networks) have been introduced. Such models are characterized by a re-connection or close communication among producers and consumers, allowing the development of new forms of relationship and governance of the actors' network, enhancing a re-distribution of value for primary producers [6].

With the aim of shortening distances and obtain a closer relationship between producers and consumers, new networks based only on two types of actors (producers and consumers) are emerging. Scholars used to refers those short agri-food supply chains with the term Direct Agri-Food Chains (DAFCs) [7]. A fundamental DAFC characteristic is given by the fact that an agri-food product is 'embedded' with value-laden information, concerning the mode of production, provenance and distinctive quality assets of the product, when it reaches the consumer. Here, agri-food is meant to be a product that is mostly farm-originated and intended for human consumption; the term is often used to refer to natural food, i.e., food that is minimally processed and all of whose ingredients are natural products (in the chemist's sense of that term). Nowadays, the consumer's opportunity to access to more food information and the capability to exchange information and opinion with peers, is gradually shifting the balance of the competition. Consumers with more information will feel more powerful as they can make informed choices, and are prepared to assert their rights and to complain about poor quality of food products and services. In particular, consumers' information empowerment, i.e. the consumers' enhanced ability to access, understand and share information [8], is gaining more and more importance. In fact, the possibility for consumers of "being in control" and "of being smarter" is crucial to carry out better food-related decisions during their food consumption activities.

Consumers are giving more and more importance in acquire knowledge related to the food domain. In fact there is growing belief that food is not only human's most important need, but also a complex psychophysical and socio-cultural object rife with symbolic and physical meanings that have profound significance for our wellbeing. Apart from biological reactions towards food products we consume, the perception and conceptual understanding of food is determined by what we learn in food experiences we start forming already as infants and continue to form in informal environments as adults throughout the life. Food learning involve multiple learning processes (psychobiological, cognitive and social) that can be both formal and informal. At its core, it

has the concept of food literacy learning that refers to acquire "the relative ability to basically understand the nature of food and how it is important to you, and how able you are to gain information about food, process it, analyze it, and act upon it" [9]. Beyond enabling a person to accurately read food labels and to understand basic nutrition enough to apply that knowledge to meal preparation, food learning also encompasses the acquisition of knowledge about how food is grown and produced, who is producing it, how production affects the environment and who has access to what kinds of foods. In few words, it encompasses the positive relationship built through social, cultural, and environmental experiences with food enabling people to make decisions that support health and wellbeing [10].

Moreover, it is worth to say that over recent years, learning opportunities for food consumers are continuously increasing thanks to recent advances in ICTs. New mobile app-based services let consumers to obtain relevant and appropriate food knowledge than those usually obtained through traditional channels like mass media and product labels [8]. Mobile app-based services are particularly suitable to be used for effective and efficient food knowledge management. Potentially, these services could provide relevant knowledge, by leveraging on many app functions, such as food-related category browsing, social networks integration, and context-awareness searching (i.e., ability to catch data to understand enough of a user's context) [11].

Previous research works on Short Agri-food Supply Chains [7] highlight that DAFCs offer several learning opportunities for food consumers, thanks to continuous interactions and knowledge exchange between community members.

In the knowledge domain of agroecology and agri-food systems, some studies on situated learning have been addressed to the formulation of education strategies [12]. However, little research has been devoted to study situated learning in alternative agri-food networks under an organizational perspective. In particular, academic researchers have mostly neglected situated organizational learning in DAFCs thus far. Moreover, few works addressed the role of mobile application in supporting learning opportunities for food consumers.

In particular, we aim to address the following research questions:

How learning opportunities for consumers occur in DAFCs? Do mobiquitous services enhance learning opportunities to food consumers?

This paper is aimed to assess the offering of app-based services supporting food knowledge acquisition for consumers. We restrict our focus on situated learning opportunities (SLOs) that arise in DAFC organizational practices where people are involved in social commitment, intersubjective relations, discursive practices, and interactions with materials in their surrounding environment.

In our study, we identify SLOs that arise in any DAFC basic forms, through a characterization of SLO constitutive elements (face-to-face interactions, knowledge and information sources, and related content learning domain) and their interrelations. We investigate how the applications of mobile services, currently employed in real-world DAFC initiatives, supports such SLOs. We propose a multidimensional framework that can be used to model knowledge exchange in a specific domain, namely the food sector.

2. Backgrounds: DAFC basic forms, situated learning, and mobiquitous services

DAFCs bring together producers and consumers in many different organizational basic forms (or their combinations) depending on social and cultural characteristics of reference territories. Basic forms are discussed in [7] and they may be summarized in the following table.

Table 1: Basic Forms of DAFCs.

DAFC Form	Description
Direct (on farm) sale - DoFS:	it refers to direct selling od agri-food products in the place/space of production. DoFS includes on-farm stores (FS), or roadside stands, where a grower establishes a selling stand for agri-food products grown exclusively on the farm; agritourisms (AT) which also provide consumers with recreation, hospitality, meal, farm tour and education opportunities; pick your own (or U-pick) operations (PYO), that allow consumers to gather products by their own directly from the field.
Box schemes - BSs	They involve local consumption groups and famers' cooperatives participating to a common agreement to ensure a regular procurement of seasonal food grown up in a sustainable way in the local community or its close surroundings. In more collaborative forms, like Community-supported agriculture (CSA), community members may purchase a share of agricultural production by paying in advance, assuming the risk/benefit of a poor or very productive season with the producer.
Farmers' markets – FMs	In these markets, producers directly sell their own "local" agri-food products (usually produced within 50 km from the market place) to consumers attending the market. In some cases, FMs evolve into collective farmer shops (CFSs), where farmers act together to set up and jointly manage a shop in a market town where products are sold by some of the farmers themselves.
Collective buying groups – CBGs	They are organized group of consumers that commonly and directly buy from selected producers. CBG members define quality criteria for products to purchase, share their "shopping lists", and create a unique cumulative order submitted to each producer who is charged to deliver ordered products to a unique pick up site
Collective kitchens or Community kitchens – CKs	They are community-based cooking programs where small groups of people come together at designated times to buy in bulk and cook healthy local food that often is eaten together or is taken home to their families. CK members share resources (kitchens, and cooking facilities), costs of food and food preparation labor, as well as socialize with other community members. In some cases, local farmers teams up with CK participants, delivering locally grown food at the kitchen and providing advices and support.

Although the above described DAFC forms are mainly focalized on distribution/selling processes, each of them provides a liminal space for situated learning that subverts the normal experience of food shopping [13], and where a variety of local lay knowledge related to agriculture, rural economy, the environment, food production, healthy eating and consumer values, may be exchanged [14].

Here, local lay knowledge refers to the knowledge utilized by DAFC actors in agri-food processes in the specific agri-ecological context where they operate. It includes "knowledge about production and preparation techniques, local natural environmental processes and the characteristics of the product" [14].

Situated learning places a learner in a setting where the process of gaining knowledge is contextualized in an experiential framework. Situated learning has been studied under multiple perspectives and applied to different knowledge domains, especially in the area of agroecology and agri-food systems [15]. In any perspective, it is a social process whereby knowledge is co-constructed; it is not viewed as a simple transmission of abstract and

decontextualized knowledge from one individual to another, but rather as a process that is situated in a specific context and embedded within a particular social and physical environment.

The situated organizational learning perspective views learning as an ongoing process that involves a complex interplay between individuals, work units and the overall business processes of an organization. Knowledge is situated within certain social and organizational contexts and embedded in certain social practices as it is formed by connections between individuals, social groups and artifacts. In the learning process, an individual may opt to discuss, relate, inquire and interpret information according to his or her own understanding and experiences. This process may, therefore, involve persuasion, building trust and faith, antagonism and a rejection of ideas and facts of the learner, which is situated within a particular event or action where learning actually takes place. The learner is bound or constrained by the external environment in which he or she is located and which determines what he or she can learn, how much, and in what ways [16].

During the past few years, there has been increased recognition of the importance of situated organizational learning and local lay knowledge exchange in agri-food systems. Many scholars affirm that appropriate learning relationships among people acting in agri-food cultural settings may:

- revitalize local/traditional knowledge [17];
- encourage sustainable land management [18] ;
- engender trust and cooperation within an agro-ecological community [19];
- educate consumers about where their food comes from, including the environmental and social conditions of its production [20].

Situated organizational learning may occur in many different ways: story-centered learning, experiential and reflective cognition, cognitive apprenticeship, collaborative learning, coaching, multiple practice, articulation of learning skills, and technology-based learning (e.g., mobiquitous learning) [21]. Many features of these ways of learning are naturally embedded in interactions that occur in DAFCs. As matter of fact, as producers and consumers are involved in agri-food activities (e.g.,transactions), they stay engaged in social relations and actively participate to experiential learning that is grounded in the actions of DAFC situated contexts [22]. They situationally acquire tacit and explicit knowledge that can be successively explicated and transferred to similar situations. Moreover, as they directly interact with each other in a situated context, they learn faster and better than others involved in out of context experiences (e.g. reading a book at home) that often require mediated feedback cycles.

Mobiquitous based learning refers to learning processes supported by emerging app-based technologies. “Mobiquitous” is a term recently introduced in literature to stress the strategic convergence of mobile and ubiquitous technologies. Thus, mobiquity is a broad concept that encompasses other concepts such as context-awareness, ubiquity, pervasiveness, and mobility. Mobiquitous learning (elsewhere called context-aware ubiquitous learning, u-learning, or pervasive and mobile learning) has been recognized as being a promising

paradigm for situated learning [23]. It is broadly defined as a learning process where pervasive and mobile computing takes part in an experience of immersion as a mediator between the learner's mental (e.g., needs, preferences, prior knowledge), physical (e.g., objects, other learners close by) and virtual (e.g., content accessible with mobile devices, artefacts) contexts [24].

A mobiquitous learning approach employs mobile, wireless communication and sensing technologies (e.g. GPS, RFID, NFC, QR codes) to provide mobiquitous applications and services that support situated learning in real-world environments [25]. Mobiquitous services and applications may provide context-aware knowledge and may augment situated organizational learning opportunities for people involved in real life DAFC activities.

3. Modelling situated learning opportunity in DAFC

A situated learning environment places people in authentic learning situations where they are actively immersed in an activity while using critical thinking skills. It provides opportunities for learning in a situated context where people are required to tap their prior knowledge and to challenge others in their community. In a DAFC, consumers may learn the story and background of the producer, and the cultural significance behind a product tied to specific method or place of production. Moreover, they may "recover skills and knowledge that have been lost along with the change of purchasing and eating habits. For example, knowing seasonality and variety of vegetables (there are a lot of species unknown to citizens), learning how to cook them (to make them edible and more tasty, but also less monotonous), and how to preserve them (vegetables and milk are "naturally" perishable, while bread lasts longer)" [26]. We model of a situated organizational learning opportunity (SLO) in a DAFC as a triplet of components that are interrelated: face-to-face interaction (F2FI) in an authentic context, knowledge and information source (KIS), and learning content domain (LCD). A graphical representation of the model is given in Figure 1.

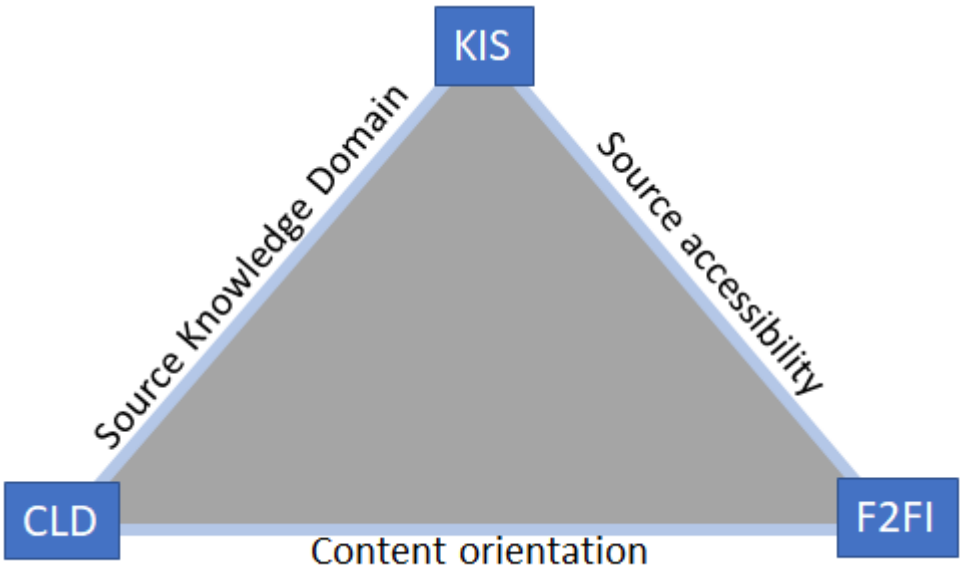

Figure 1: SLO components and their interrelationships.

Let us discuss now the three SLO components and their interrelationships.

3.1 Face to face interaction (F2FI) situated context

F2FI is the process in which two or more persons are physically co-present (in a way that allows for mutual visual and physical contact) and influence each other's actions. Participants are involved in in an almost instantaneous cycle of interruption, feedback and repair the interaction, as they interchange ideas, and attempt at problem solving in a social, economic, physical and environmental context where they act. From a situated cognition perspective, learning becomes a process of sharing narratives, reflecting, interpreting, and negotiating meaning among the F2FI participants as well as their community. In a DAFC, F2FIs enable situated learning processes where producers and consumers build new relations through which a large share of 'tacit knowledge' is made explicit, as they both benefit from the shorter distances, better information flow and greater trust between them [4]. A F2FI provides many sensory, cognitive and social cues that allow participants to connect the information exchanged content with the social, economic, physical and environmental context that embeds it (e.g., connection of the agri-food to the natural environment where it comes from, to dietary nutritive values, to social dynamics in food producing, distributing, consuming and disposing). These cues are context-dependent, since they are related to things from the environment and situation where learning may occur. They may regard the F2FI location, the appearance, taste, and consistency of an agri-food product, and so on..

In what follows, we consider context items that shape a F2FI in a DAFC, and play a significant role in providing opportunities for situated learning.

- **Participants**. This item determines the current F2FI participants and their relationships. Participation is seen in terms of expressing and discussing ideas, developing plans, evaluating actions, and decision-making. Participants are DAFC people (consumers, producers and organizer) and they are described by some main attributes that include:
  - **profiles**: *personal profile* (name, physical characteristics, such as age and sex, languages spoken, preferences, disabilities, …), *social profile* (friends, community role, …), and *activity profile* (current activity, participant role, work schedule, meetings, …);
  - **personal behavior**: *mental properties* (belief, desire, need, …) and *motivation type* that may be social (e.g. tighter relationship with others, social belonging.), ecological (e.g. lower environmental impact), economical (e.g. disposable income/budget impact), or personal wellbeing (e.g. physical and mental health, pleasant time).
- ***Time***. This item specifies when the F2FI occurs. It determines the F2FI temporal context in terms of season (spring, summer, ...), day time (morning, afternoon, …), DAFC stage time (production, distribution, consumption, or waste management), event time (DAFC people meetings, …) and other time-related properties of the F2FI.
- **Location**. This item determines where the F2FI occurs. Beyond the absolute position (e.g. exact degrees of longitude and latitude), the spatial context is identified in term of properties of the F2FI place (e.g. a farm site, where DAFC product is coming from, an agri-food terroir, i.e. the land bestowed upon DAFC product, or a proximate area, i.e. an area that is proximate to the agri-food

terroir).

- **Environment**. This item specifies conditions of the physical and organizational environment surrounding the current F2FI. It includes:
  - ***agri-food:*** physical properties of agri-food products that are present in the current F2FI physical context. Value-laden information embedded within these products can be processed by F2FI participants. For instance, the presence of a product in a F2FI may concur to create an opportunity for experiential learning about quality assets (varieties, taste shapes, textures and aromas) of agri-food;
  - **environmental conditions**: physical properties like light, humidity, temperature, and spatial layout of the environment;
  - **organizational form**: principles, values, policies, and governance rules of the DAFC organization that drive or constrain the behavior of participants in a F2FI;

The values of these items depend on the particular form of the DAFC, and they have a great importance in creating good opportunities for situated learning in a F2FI.

3.2 Knowledge and Information Source (KIS)

In a DAFC, there are many potential sources of information and knowledge that can be processed, used and involved in a situated learning process. Such knowledge can be made accessible through suitable technological devices (e.g., mobile devices), and it can be integrated into a situated learning experience to support reflection and first-person engagement with the learning content matter. Moreover, it constitutes a powerful and flexible resource that can be deployed to support a contextualized F2FI. KISs can be classified into:

People. DAFC people (i.e., DAFC community members, regarded as individuals) constitute KISs, since they possess individual knowledge, independent of an organizational entity's existence, that can be exchanged in a situated learning process. We may distinguish between personal and crowd KIS. The former is a private KIS that is an organized collection of personal information concerning an individual; it is usually accessed only by the individual concerned and it may provide him/her with information and knowledge (e.g. a personal agenda, own nutritional and dietary needs, own recipes, …) useful for an ongoing situated learning process or for retrospective learning. In the latter, contributions are collected, and accessible from a large group of people. For instance, a crowd KIS allow people to share information and knowledge about the farm origin of agri-food, including the environmental and social conditions of its production, the cultural significance behind agri-food tied to specific method or place of production, as well as information and knowledge about taste, culinary uses and sales responsiveness of agri-food products.

Organization. Any organizational entity (e.g., a producer, a consumers group, a group leader, a farmer-driven board of directors, a vendor-consumer advisory committee, a FM operator) in a DAFC is a source of organizational information and knowledge that is embedded within the behavior that manifests in the overall DAFC organization through its culture (values, principles, norms, traditions, unwritten rules, and informal procedures), its structure (roles, relationships, and regulations that govern their use), and its business function (activities or tasks, such as planning, production, sales, performed together to obtain a defined set of results).

For instance, a FM operator could provide information and knowledge about market prices and even latest agricultural practices that are essential in creating opportunities for small producers to learn about their economic performance.

Extra-organization. External entities (e.g. input providers, certifying and extension agencies, NGOs, governments, financial service providers, research centers and other agri-food organizations) operating in DAFC surrounding (socio-political, economical, bio-ecological) environments constitute a KIS. For instance, research centers and other agri-food organizations may serve as a source of expert information for small farmers who can learn about the application and use of nutrients and pesticides.

3.3 Learning content domain (LCD)

Content situated in F2FIs becomes the means to engage in reflective thinking that is part of higher-order thinking processes based on the acquisition of facts dependent on real DAFC activities. By placing content within a F2FI, participants negotiate the meaning of content, frame it in terms of agri-food issues, provides opportunities for them to cooperate in investigating problem situations, and makes content applicable to the ways in which they will approach the environment.

The elements of LCD are determined along two main dimensions:

- **learner target**. It is the type of learners that can benefit the learning content (who is the learning for?). The type is specified in terms of characteristics of consumers, producers, or organizers that participate at DAFC activities;
- **learning content orientation**. It is the category of learning object content (i.e., the information and knowledge about factual matters) that enables situated learning through F2FI in a DAFC. The categories are:
  - agri-food product: it is the category of content items regarding attributes (e.g. price, seasonality, varieties, taste shapes, textures and aromas of agri-food) of products exchanged in a DAFC;
  - people: it is the category of content items that are useful to learn about a person (e.g. trustworthiness, loyalty, integrity, wishes and needs) belonging to a DAFC community;
  - operations: it is the category of content issues about operations (e.g., agricultural practices, processing methods, buying/selling, food preparation) at any DAFC activity stage (production, distribution, consumption, and waste management);
  - organization: it is the category of content items that are useful to learn about roles, relationships, and regulations that govern their use in a DAFC;
  - culture: it is the category of content items that are useful to learn about norms, values, experiences, and history of a DAFC;
  - environment: it is the category of content items regarding social, economic and natural aspects of the environment surrounding a DAFC.
  -

3.4 Relations between components

The SLO components F2FI context, KIS, and LCD are interrelated, as depicted in figure 1, and their relations are described as follows:

F2FI context-LCD: it associates F2FI context elements with information content elements of the LCD (i.e., information about factual matters). For instance, information on seasonality and shelf life of agri-food products can be exchanged as they are present in the F2FI context, or information on organization culture of a DAFC can be exchanged as its norms and values are discussed in a F2FI;

F2FI context-KIS: it specifies which KISs are associated with F2FI context elements. A KIS may be made accessible by its physical presence in a F2FI (e.g. an agri-food product) and/or by employing some technological tools (e.g. a mobiquitous application that enables access to an organizational database in order to learn about the sale, movement, and distribution of produce along the DAFC);

KIS-LCD: it specifies which KISs may be exploited to learn about some LCD elements. For instance, a research centre may be a DAFC external source of scientific knowledge that can be exploited to let farmers to learn how to grow better quality, higher-yielding crops.

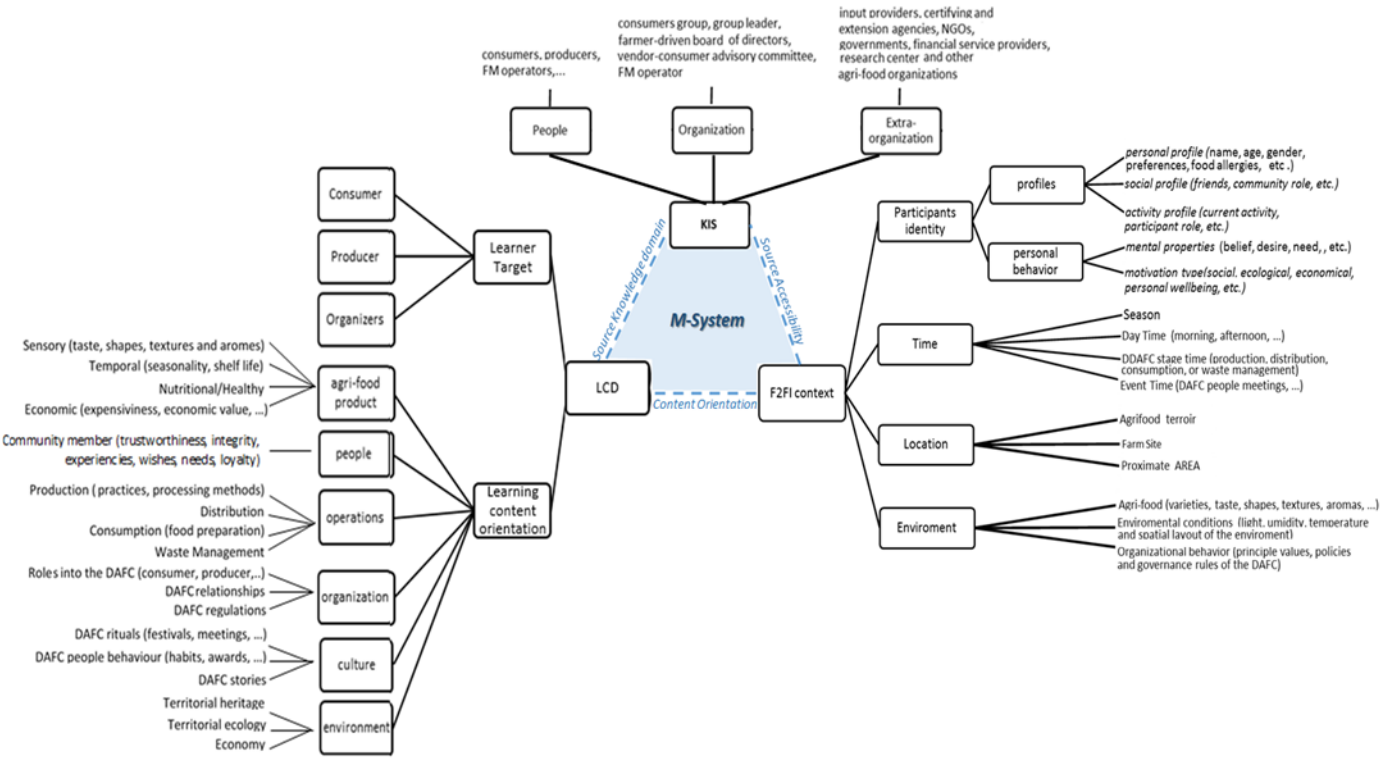

Figure 2: Detail of SLO components.

4. Augmenting SLOs through mobiquitous services

Augmented learning (AL) is defined as an on-demand learning technique where the learning environment adapts to the needs and inputs from learners [27]. The "environment" here may not be confined to the physical context, but it could refer to a combination of a physical and virtual space, through which learners can stimulate discovery and gain greater understanding. Such an innovative learning space is aligned with the constructivist paradigm of learning where learners control their own learning, through the active interactions with the real and virtual environment. Mobiquitous learning is a natural approach to AL. By and large, mobiquitous services have characteristics of pervasiveness (i.e., capability to be accessed and provided over a multitude of different devices in the environment) and context-awareness (i.e., ability to understand enough of a user's current situation in order to effectively meet users' needs by performing actions and offering information relevant to the particular context). Their employments provide untapped opportunities for a new genre of physical–digital interactions that can support situated learning, allowing people to make explicit connections between their various perspectives and understandings of the physical and digital worlds both at the same time. Mobiquitous learning services are normally provided on mobile devices (tablets, smartphones, smart devices, etc.) using a downloadable application through which learning contents can be geared toward learners needs by displaying plain texts, images, audio and video output. Moreover, augmented reality (AR) represents a great potential field to be exploited in order to conceive innovative mobiquitous learning systems for AL. AR is a novel way of combining, aligning and registering virtual and real objects in a real environment through interactions with them in real time, [28]. AR does not refer to the mere availability or presence of digital media within a particular location, but rather to the fact that such digital media may "supplement or augment our surroundings through additional information being made available (e.g.visually, auditory or through haptic interfaces) that has contextual relevance to that specific place" [29]. As matter of fact, todays, there are hundreds of AR apps that can be embedded in mobiquitous applications supporting everyday situated learning processes.

In a DAFC, mobiquitous applications provide new opportunities for serving awareness and transparency needs of consumers as well as request of information of producers on their business processes, while a F2FI takes place. For example, a mobiquitous application may be used to provide farm site or agri-food product information (processing methods, provenance of the produce, agri-food physiological and health aspects, etc.) in digital format (labels, pictures, videos, geo position, and graphics) on a learner's individual "heads-up display" or through headphones for audio content.

Moreover, the integration of new technologies, such as object recognition, feature tracking, RFIDs, Near Field Communication (NFC), geotagging, and web services, in mobile devices has enabled to conceive mobiquitous services that make the real context of a SLO more effective under a cognition perspective.

The use of mobiquitous services has great potential to enrich the SLO components and their interrelationships, and, in this sense, we say that it leads to augmented SLOs. Thus, we may extend the SLO model, presented in section 3, by adding to it a fourth component: mobiquitous service (M-Service).

4.1 The role of M-Service in a Situated Learning Opportunity

A M-Service is based on a context-aware application that runs on a computing infrastructure (i.e., a network of sensors, embedded subsystems, portable devices owned by mobile users, remote or local servers, etc.) in order to enhance abilities of users in executing tasks and activities in their environment. This kind of services may facilitate and support learning activities by making use of knowledge structures (e.g., predefined ontology and rule-based reasoning) and information of the context of the interaction between user and M-Service (e.g., relationship among users and between people and objects, time and place of interaction, spatial layout and other physical conditions of the environment surrounding the interaction).

When a M-Service is put in place, an information flow that matches learner's needs and improves the learning situation can be provided. This information flow can be "informational", i.e. information that influences the user behaviour is only pushed from a mobiquitous application to the user, "reporting", i.e. information that influences the M-service behaviour is only pulled by the mobiquitous application from the user, and "interactional", i.e. a bidirectional information flow that influences both user and M-service behaviours occurs between the user and the mobiquitous application. The aim is letting people to learn at any time and any place by providing them with the right information at the right time in the right way.

The employment of M-Services in DAFC activities may enhance and extend SLO along the following directions:

Permanency. F2FI context information and explicit information exchanged before/while/after a F2FI are acquired, recorded and stored permanently by the M-service, possibly on pervasive devices. This could happen in the foreground of F2FI participants 'attention through explicit human interaction (command-based interaction) with the M-Service interface, or in the background of F2FI participants' attention through implicit interaction with a sensor and wireless network.

Accessibility. DAFC people have immediately access to documents, data, or videos from anywhere at any time, provided that current interaction context requires it. Information, possibly stored, on pervasive devices can be pulled by the user that intents to retrieve learning content, or can be pushed by the M-Service when it determines that some interaction context conditions are met.

Interactivity. In a DAFC community, people interact with each other and the environment, in the form of synchronies or asynchronous communication mediated by the M-Service. Learning activities can be integrated into the real-world DAFC environment where sophisticated and interactive knowledge services can be provided.

Situatedness. The M-Service is aware of some F2FI context items (i.e. participants, time, location, and environment) by implicitly detecting their status via the sensor network or by explicit human interaction with it. It could let people learn about features of problem situations occurring in DAFC activities and let them link learned knowledge to the corresponding situation.

Adaptability. The M-Service delivers learning content that is adapted to the current F2FI context, by using various devices, in order to meet individual learning needs of F2FI participants. DAFC people can obtain the right information at the right place in the right way as they are attending DAFC activities.

In addition to augment a SLO while a DAFC activity takes place (learn while doing), the employment of a M-Service gives the chance to expand a SLO beyond physical constraints (e.g., time and space) of a DAFC activity. Such expansion enables:

- *learn before doing*. A M-service may assist to share information and knowledge that is necessary for preparing a SLO, i.e.:
  - selecting F2FI participants and setting time, location and environment of a F2FI;
  - determining KISs and related LCD elements that concur to create a SLO.

A M-service may enable learning what is supposed to happen at a certain DAFC place at a certain time, learning what knowledge is needed to perform a certain DAFC activity which involves a F2FI, and where it can be acquired from.

- *learn after doing*. A M-service may support learning in hindsight after the completion of a DAFC activity and the related F2FI. This kind of learning is triggered by reviewing both information and knowledge exchanged in previous F2FIs and experience-based DAFC activities and events. It may identify SLO patterns (in terms of SLO components and their relationships) of great utility for setting future SLOs. Pattern knowledge sharing may be facilitated by a M-service that enables connection and collaboration among DAFC people, e.g. by using social media tools.

5. A Framework to analyze app-based services for DAFCs

In what follows we propose a framework to analyse Situated Learning Opportunities occurring through mobile applications for DAFC

Mobile Applications (or apps) are downloadable programs designed to run on a mobile device (e.g., smartphone, tablet, …) operating system. They are coded in a specific programming language (e.g., Swift for iOS, Java/Dart for Android) and they require installation on the device and run locally on the device. Moreover, they also have access to mobile device resources, such as built-in device sensors (e.g., accelerometer, GPS, ambient light, dual microphones, proximity sensor, dual cameras, compass, and gyroscope) and local databases (e.g., an address book, calendar).

This characteristic makes apps particularly suitable to be used in M-services.

We restrict our attention only on those apps that utilize the built-in smartphone sensor technology (albeit in a limited capacity) and could provide an augmentation of a SLO, even if most of them are business oriented rather than learning oriented.

The following table synthetize classification criteria we identified

Table 2: Classification Criteria

Feature	Entity	Values
User Context	User Type	*DAFC community member*, *unspecified*
	Time	*before F2FI*, *while F2FI*, *after F2FI*
	Location	*dependent* (if the M-service requires the user to be in, or proximate a DAFC site) *independent* (otherwise);
	Organizational form	*Farmers' markets*, *Direct (on farm) sale*, *Box schemes/Community-supported agriculture*, *Collective buying groups*, *Collective kitchens or Community kitchens*);
KIS	People	*Personal (*when the KIS is a person who manages his/her own personal data and information), *DAFC crowd*, (when the app function allows information and knowledge sharing among DAFC members), *uncontrolled crowd* (when the KIS is formed by an undefined crowd, i.e., registered and unregistered app users or even not app users).
	Organization	*Internal* (when the KIS is a DAFC organizational unit), *mediator* (when the KIS is an infomediary, i.e., a third party between DAFC organizations and DAFC people), *external* (when the KIS is a well-recognized organization, external to DAFCs).
LCD	Learner target	*Consumer, producer, organizer*
	Learning content management	*reporting (*when the function allows a user to feed content into a KIS, through edit, capture and transmission of content), , *informational* (when the function supports content delivery from a KIS to a user through some push mechanisms), *interactional* (when the function enable a bidirectional information flow between the user and a KIS
	Learning content category	*agri-food product*, *people*, *operations*, *organization*, *culture*, *environment*
Mobiquitous	Context awareness	*user's identity*, *location*, *time*, *environment object*
	Pervasiveness	*agri-food product* (when an input sensing device, e.g. a RFID tag, is attached to an agri-food product or its packaging), *space* (when an input sensing device, e.g. a smart poster, is attached/embedded to a physical resource in DAFC space), *people*, when input sensing devices, e.g. smartcards, are owned by DAFC people.

App functionalities can be classified according the following criteria, as shown in table 3.

Table 3: Types of App Functions

Social oriented	Social reporting	Social push	Social searching
Decision support oriented	Decision support reporting	Decision support push	Decision support searching
			Task automation
	reporting	***informational***	***interactional***

During an interaction with an app function, an information flow (content with its metadata) is established between the app user and the M-service. The proposed classification considers both the information flow direction (reporting, informational, or interactional) and the function scope (social oriented or decision support

oriented) of an app function.

Social oriented app functions enable communications among DAFC people: They support social interaction, or so-called "sociability", in order to build social relations among DAFC people who share interests, activities, backgrounds or real-life connections. Basic communication features and information/knowledge sharing (recommendations, videos, photos, …) within DAFC community are provided through either an internal social channel or through connectors to existing external social channels (as Facebook or Instagram). The kind of connections may vary from embedding social feeds into the app, in-app sharing (i.e., sharing content from inside the app through the external social media), up to more complex integrations of social functionalities into the app through API calls to external social network (e.g., an engine aggregating content generated from users and providing user-friendly information feed).

Decision support oriented app functions manage information for supporting DAFC people's decision making: They provide an app user with decision-making support and means to act on decisions before a F2FI event (e.g., selecting trustworthy F2FI counterpart, providing information for pre-purchasing decisions, adhering to loyalty programs), during a F2FI event (e.g., gathering and providing F2FI context dependent information to make better purchasing decisions), and after a F2FI event (e.g., providing history information for reviewing agri-food transactions). They represent an aid for self-directed situated learning by providing relevant information on LCD objects and assistance to perform an action in DAFC operations.

Reporting: app functions allow a user to feed content into a database, related to a KIS, through edit, capture and transmission of content. A **social reporting function** allows an app user to access a social media channel and to post messages in order to bring out them to a broad audience; it stimulates and captures different types of conversation, enriching insights and learning that happen before, during, and after a F2FI event. Messages are subjective content contributions that revolve around the beliefs, opinions, judgments, and perceptions of individuals in a crowd. They are simply aggregated by the M-service, generally without performing any validation of them. A **decision support reporting** function allows an app user to create and insert into a database related to a KIS a structured report on factual matter for supporting a personal or organizational purpose. A structured report consists of a body (i.e., the report content) and other metadata fields, according to a predefined data model. In case of organizational purpose, the organization can evaluate and filter user's contributions before being considered on their relative merits in order to achieve an impartial and unbiased information.

Informational: app functions support content delivery from a database, related to a KIS, to a user through some push mechanisms. Pushing functionality allows app users to rely on various message streams from a KIS to them, as they gave permission at the time of app install on their device (mobile operating systems store permission settings and allow users to change these settings at a later time). These streams are available through the app installed on user device and when a message is published it is pushed on to user devices and arrives as push notification. In **social pushing** messages are generated by a user belonging to a crowd, while in **decision support pushing** messages are generated by a user belonging to an organization.

Interactional: app functions enable a bidirectional information flow between the app user and the M-service. Searching functions enable an app user to select a subset of items from a database, related to a KIS, according to his/her information needs. In practice, the user takes (or is given) the initiative and interacts with the app in order to specify item metadata to pass to the M-service for identifying item contents and getting them on his/her own device. The interaction may be performed either by browsing a classification hierarchy (e.g. a geographically orientated browsing) and iteratively narrowing the scope of his/her quest in a predetermined order, or by entering keywords in a query for keyword searching over a database. In **social searching**, the search is performed on messages posted on a social channel by users belonging to a crowd. In **decision support searching**, the search is performed on items that are structured according to an adopted data model. **Task automation functions** enable an app user to rely on the actual automation of some tasks (related to the M-service) characterized by standardized and repeatable patterns of information processing. For instance, some steps of an e-commerce transaction that supports buying specific types of agri-food products can be automated by using an app: purchasing specific products is a standardized task, once the customer has decided on a particular agri-food product to purchase (the process is conducted the same way for any app users independent on what product they choose to purchase). Task information results are often used to feed a database, related to an organization KIS, usually according to some privacy policy in order to fulfill both user preferences and legal requirements.

The information flow associated to each app function can be analyzed by identifying its **content** (e.g., data, text, links, images, video, etc.), **context-oriented metadata** (e.g., name, location, and time of the content author), **content-oriented metadata**, some of which may refer to LCD categories described in section 3.3 (we call them *LCD-oriented metadata*), and **KIS** that the user interacts with through the app function. Following the SLO model, we can map each app function into a function analysis space, as it is shown in figure 3 and described below.

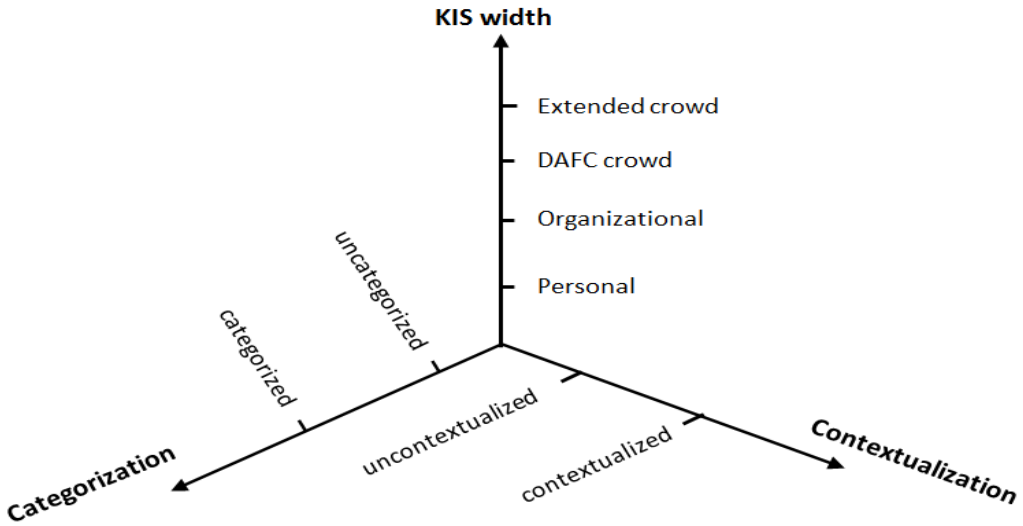

Figure 3: The function analysis space.

Table 3: A description of the function analysis space value.

Dimension	Value	Description
KIS Width	*extended crowd*	This value is associated with app functions that enable an information flow between the app user and users of an external social network (e.g., Facebook, Twitter). This is the case for social reporting functions that allow an app user to post messages to an external social channel (*inside-out posting capability*), social pushing functions that provide the app user with a message stream from an external social channel, social searching functions that enable an app user to select a subset of messages from an external social channel according to his/her information needs.
	DAFC crowd	This value is associated with app functions that enable an information flow between the app user and users of an internal social network provided by the M-service. This is the case for social reporting functions that allow an app user to post messages to an internal social channel (inside-in posting capability), social pushing functions that provide the app user with a message stream from an internal social channel; social searching functions that enable an app user to select a subset of messages from an internal social channel according to his/her information needs.
	Organizational	This value is associated with app functions that enable an information flow between an app user and an organization. We also associate the app function with a sub dimensional value that may be *internal*, when the organization is internal to a DAFC, or *mediator*, when the organization is a third party between DAFC organizations and DAFC people.
	Personal	This value is associated with app functions that enable an information flow between an app user and himself/herself. This is the case for functions that facilitate an app user to record and retrieve its own personal information; for instance, such information may regard notes or memo (shopping list, calendar, ..), nutritional/ dietary info, things to-do list, list of favourite items in some LCD category.
Categorization	*Categorized*	This value is associated with an app function whose information flow contains item contents and content-oriented metadata that refer to a same LCD category. These values are associated with a o reporting function that requires the app user to specify LCD oriented metadata of the report content, generally by selecting metadata from a LCD taxonomy (in the simplest case, a menu list of values); o pushing function that provides the app user with a stream of messages all classified in the same LCD category; o searching function that allows an app user to retrieve information on items of a LCD category, browsing a LCD taxonomy (in the simplest case, a LCD category list) or searching by LCD category keywords.
	Uncategorized	This value is associated with an app function whose information flow contains items that could be either related to different LCD categories or not related at all to any of them.
Contextualization	*Contextualized*	This value is associated with an app function whose information flow contains item contents and context-oriented metadata that characterize specific situations (contexts) in which the items have been created or used.
	uncontextualized.	This value is associated with an app function whose information flow contains items with no context-oriented metadata.

Since an app may provide many functions of a same type, but with different dimensional values, each reviewed app can be mapped into three-dimension spaces (one for each function type) by assigning it three dimensional values as specified in the following table:

Table 4: How to map functions of M-Services for SLO in DAFCs.

Dimension	Value	Description
Categorization dimension value:	*knowledge-based*	if the value categorized is associated with all its functions of the considered type;
	partially knowledge-based	if the value *categorized* is associated with some, but not all, of its functions of the considered type;
	no knowledge-based,	if the value *uncategorized* is associated to all its functions of the considered type.
Contextualization dimension value:	*context-driven*,	if the value contextualized is associated with all its functions of the considered type;
	partially context-driven	if the value *contextualized* is associated with some, but not all, of its functions of the considered type
	no context-driven	if the value *uncontextualized* is associated to all its functions of the considered type.
KIS width dimension value:	*no DAFC community oriented*	if the value *extended crowd* is associated with all its functions of the considered type (i.e. a social oriented type);
	partially DAFC community oriented,	if the value DAFC crowd is associated with some, but not all, of its functions of the considered type (i.e. a social oriented type);
	DAFC community oriented	if the value *DAFC crowd* is associated with all its functions of the considered type (i.e. a social oriented type);
	organizationally oriented	if the value *organization* is associated with all its functions of the considered type (i.e. a decision support oriented type
	organizationally & personally oriented	if the value *organization* is associated with some, but not all, of its functions of the considered type (i.e. a decision support oriented type) and the value *personal* with the other ones
	personally oriented	if the value personal is associated with all its functions of the considered type (i.e. a decision support oriented type);

6. Conclusions

Mobile applications represent a promising tool to support situated learning opportunities for consumers in direct agrifood chains. This paper attempted to provide a framework to assess the offering of app-based services supporting food knowledge acquisition for consumers. We restrict our focus on situated learning opportunities (SLOs) that arise in DAFC organizational practices where people are involved in social commitment, intersubjective relations, discursive practices, and interactions with materials in their surrounding environment.

In our study, we identified SLOs that arise in any DAFC basic forms, through a characterization of SLO constitutive elements (face-to-face interactions, knowledge and information sources, and related content learning domain) and their interrelations. We investigated how the applications of mobile services, currently employed in real-world DAFC initiatives, supports such SLOs. The framework we proposed allow to analyze to what extent the mobile applications aimed at supporting DAFCs are able to support situated learning. This study assumes particular relevance in the context of innovative organizational models proposed by DAFCs, since knowledge exchange and situated learning opportunities may represent an emerging element for the value proposition of companies within a DAFC. In particular, the use of mobile technologies in DAFCs enables intense and efficient information and knowledge sharing, allowing producers and consumers to obtain

personalized information and knowledge at the right time and in the right place, regardless of temporal and spatial constraints. Mobile-based technologies offers the opportunity to support mutual understanding between producers and consumers, thus favoring the creation and/or consolidation of relationships of trust and collaboration in the DAFCs. At the same time, the adoption of mobile technologies in DAFCs can contribute to the reduction of both costs associated with the promotion of such initiatives, as well as research and transactional costs. These technologies can in fact support the coordination of supply chain activities, favoring the meeting between producers and consumers, as well as increasing their operational efficiency. From a marketing-related perspective, the reference framework we proposed represent a valuable framework for positioning food information offerings on the market. In addition to that, it can be adopted to conduct surveys of other app-based services based on Situated Learning Opportunities for food consumers.

This exploratory study attempted to provide a methodological approach and a multidimensional framework to better classify app-based food information services for SLOs in DAFC. This framework represents a useful tool to analyze the offer of mobile-based services in different food sectors. An early version of this framework was used to perform a review in app-based services in the olive oil market [8]. New IoT devices (like food scanner" or "food sniffer" for biomolecular food analysis, mobile apps that use camera photos for the assessment of food quality, etc.) can drive to a new generation of food information services which could enable consumers to get their contextualized expectations and information needs.

The suggested framework is a useful tool to perform market survey research aimed to understand what kind of information and knowledge services are currently provided through mobile applications and what augmented SLOs take place in DAFC real world initiatives.

In further investigation we shall apply the framework to carry out extensive food information service reviews with the aim of identifying potentialities and limitations of SLOs for learners/consumers.

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