DEMO: Task-Based Learning in an Instrumented Kitchen

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ABSTRACT
Ubiquitous computing technologies have traditionally striven to augment objects and the environment with sensing capabilities to enable them to respond appropriately to the needs of individuals in the environment. This demo shows how such technologies can support autonomous language learning, specifically Task-Based Learning (TBL). TBL involves doing meaningful tasks in a foreign language, emphasising the language’s use in practice. TBL is seen as a highly engaging and motivating approach to learning a language, but is difficult to do in the classroom, where learners typically engage in activities that only simulate ‘real-world’ tasks and rehearse language use, rather than applying language in practice. We present the French Kitchen, a portable instrumented kitchen for English speakers who are learning French.

Categories and Subject Descriptors
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. K.3.1 [Computers and Education]: Computer Uses in Education – Computer-assisted instruction.

General Terms
Experimentation, Human Factors.

Keywords
Task-based learning, instrumented environment, situated interaction, building-people interaction.

1. INTRODUCTION
Two students stand in a kitchen. A recorded voice remarks: “Pour préparer votre clafouti, vous aurez besoin des ingrédients suivants.” (To prepare clafouti, you will need the following ingredients.) The kitchen reads aloud a list of ingredients in French, which the students jot down. Once the list is read, they fetch the items then indicate that they are ready. “Très bien” (very good) remarks the kitchen, “commençons a cuisiner” (let’s get cooking).

“Préchauffez le four à deux cent dégros,” (pre-heat the oven to 200 degrees) says the kitchen, before falling into silence. The students are not aware of the underlying system, but while they translate and carry out the instruction, the underlying system awaits a signal from the oven knobs, showing that the students are on track. A timeout is counting down: if the students do not complete this subtask within a certain amount of time, the kitchen will help by giving them a prompt.

From pre-heating the oven through to coring pears and making batter, the kitchen guides the students through each step of the recipe. The students’ use of kitchen items – whether oven knobs or utensils – guides the kitchen as to where they are in the recipe, and in response the kitchen gives prompts as needed, repeating or simplifying its language if initial prompts do not seem to help.

We have developed the French Kitchen, an instrumented kitchen to support learning a foreign language. Learning modern foreign languages offers rich rewards including improved cultural understanding, communication abilities and job prospects. In recent years the number of school pupils gaining such qualifications in the UK has decreased significantly, and the European Union has acknowledged that Europe faces specific challenges for increasing foreign language proficiency, an area which impacts the EU economy [1].

We draw on the principles of Task-Based Learning (TBL), in which learners use a foreign language to achieve meaningful goals (rather than learning via textbook-based exercises). TBL is an effective approach: using language in response to real tasks supports better learning [3]. Tasks can range from haggling for goods in a market to getting directions. However, it can be difficult to support TBL, especially in formal environments such as classrooms, which do not lend themselves to this approach. Formal learning environments afford a specific set of tasks and behaviours, but these are generally academic in nature (learning about things). By contrast, TBL calls for the use of real-world skills in real-world situations. Designing systems to support TBL is difficult, illustrated by the dearth of work in this area.

Ubiquitous computing technologies are an excellent tool to address this problem. By augmenting the environment with sensing capabilities that enable tracking of learner progress in practical tasks, and by providing situated, language-related feedback, Ubicomp systems can extend the learning experience by embedding it into everyday activities. We chose to develop a kitchen because cooking lends itself to the principles of TBL. For the purposes of evaluation, we equipped it with materials to support English speakers learning French.

2. SYSTEM DESCRIPTION
The French Kitchen leads learners through the process of making pear clafouti (a baked French dessert), automatically providing various prompts based on learner activity. These prompts include instructions, repeats of instructions, reminders, re-phrasings, tips, and translations. Learners can also navigate backwards and forwards through a recipe, and request repeats and translations of
statements. These mechanisms can increase or decrease linguistic complexity. For example, re-phrasings and translations reduce complexity, while tips introduce new vocabulary and increase complexity.

The French Kitchen was based on the Ambient Kitchen, an instrumented kitchen developed in 2009 [2]. Figure 1 shows the French Kitchen’s technical infrastructure.

Figure 1: Technical overview of the French Kitchen

Sensing & Recognition We use small, inexpensive acceleration sensors (see Figure 2) to detect kitchen activity. These wireless sensors are integrated into the handles of cooking utensils, incorporated into containers that hold ingredients, and directly attached to kitchen appliances (e.g., oven door, weighing scales). When a sensor detects movement it starts transmitting the raw acceleration data to a nearby receiver, which is connected to a host computer. We use a technique that reports motion if certain thresholds in the signal’s energy and the magnitude of its power spectrum are exceeded. These thresholds have been determined empirically in cross-validation experiments. Motion events are generated if kitchen objects, e.g., food containers or the oven door, are moved.

Figure 2: Some of the 27 kitchen item instrumented with accelerometers

Inference The French Kitchen must track progress through recipes in order to provide situated prompting and context sensitive interactions. The activities that are recognized by the S&R module are indicators for progression within the cooking task, and thus input to the recipe model. Since recipes are typically linear we focus on simple state automatons for recipe modeling that are easy to author for a human system designer. The automaton model consists of a sequence of states (each state being the task being carried out at that part of the recipe). These are associated with specific feedback actions that are used by the subsequent P&I module. Examples of these are specific spoken messages, success statements and timeout statements. Each state has a condition that must be met for it to complete, for example, an activity being recognized, a fixed time delay, or a set of activities being absent for an amount of time. If an action’s condition is not met within a defined interval, the next prompt for that action is read.

Prompting & Interaction Based on the definition in the automaton specifications and the inferred recipe progress, the P&I module provides language learners with situated support and context-sensitive interaction options. For direct interaction with the French Kitchen we use a tablet computer with a bespoke graphical user interface. This GUI guides learners through the cooking process, gives spoken prompts, and allows them to request situated support such as translations, adjustment of speed by pausing and resuming the system, and manually stepping backwards and forwards to skip or repeat steps.

All three modules of the French Kitchen system communicate via lightweight publish-subscribe middleware. Sensors are unobtrusively integrated in such a way that users of the French Kitchen are not distracted. The tablet computer is housed within a bespoke enclosure that makes it suitable for situated interaction from a kitchen work surface.

In addition to the original French Kitchen, we have built portable versions, consisting of a tablet computer (to run the software and display the GUI), instrumented utensils, and WAXs to attach to food boxes. This demonstration uses one such kitchen: our only requirements are a power socket and a table. By progressing from a large, static kitchen towards a cheaper, portable kit, we move closer to achieving our vision of enabling schools and communities to adopt these instrumented environments for both formal and informal learning.

3. SUMMARY

The French Kitchen is an instrumented environment designed to support Task-Based Learning by supporting native English speakers learning French as they cook. The kitchen consists of instrumented utensils, appliances and food items in conjunction with a tablet housed in a bespoke casing, and it provides learners with situated support that is tailored to their particular context.

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5. REFERENCES

