FEDERAL OFFICE FOR PROFESSIONAL EDUCATION AND TECHNOLOGY OPET
BUNDESAMT FÜR BERUFSBILDUNG UND TECHNOLOGIE BBT
OFFICE FÉDÉRAL DE LA FORMATION PROFESSIONNELLE ET DE LA TECHNOLOGIE OFFT

Leading House

DUAL-T: Technologies for Vocational Training

☑ Rapport intermédiaire (du 01.04.2006 au 31.03.2007)

☐ Rapport final

Prof. Dr. Dillenbourg,

_____
(Signature)

Contents

1. Development of the leading house

1.1. Scope

The DUAL-T leading house conducts research on the relevance of learning technologies for vocational training. Our main hypothesis is that these technologies should specifically address the gap that exists between the school and the workplace. The 3 projects shared a common approach to learning technologies. This approach can be summarized in 5 points:

- Technologies are designed for supporting learning *activities*; we do not focus on the management and delivery of on-line contents.
- These target activities integrate *multiple* modes of interactions: with and without computers, at distance and in co-presence settings. Computer-based activities are integrated into broader training scenarios. Teachers play a central role for orchestrating the integrated learning scenarios.
- These target activities are built around *social interactions* among students, in small teams of the whole class, and interactions with the teachers and work supervisors. Teachers play a central role for orchestrating these integrated learning scenarios.
- As the target activities produce digital objects (e.g. pictures collected in the companies where apprentices work), the management and reuse of these *emerging objects* affords new forms of learning activities.
- The diversity of professional contexts for student in the same class and the mobility of students *across contexts* afford new forms of learning activities.

These 5 oiunts constitute what we refer to as *integrated learning* framework (Dillenbourg & Jermann; 2007). Given this framework, our research projects do not focus on a single type of learning technologies (microworlds, hypertexts,…), but develop different learning scenarios / technologies specific to each domain of apprenticeship. We explore 3 domains of training: mechanics (project 1), health (project 2) and logistics (project 3). The three projects have adopted design-based research as the main method, evolving from highly contextualized solutions to de-contextualisation.

We expect our research could have an *impact* on the Swiss vocational training system by providing technology-enhanced learning methods that can be characterized in 3 points:

- *Articulation*. The learning activities we study address the gap between the activities that apprentices perform at school and those they practice at work, as stated in our objectives. A key issue that our projects face is the heterogeneity of what apprentices are asked to do at different workplaces.
- *Reflection*. The learning activities we study target the reflection side of apprentices' activities, which usually are more focused on procedural skills. However, reflection is useless if it is not grounded into concrete practice. Hence our projects do not target reflection in abstract but grounded in concreteness, namely through the analysis of daily practices.
- *Professional identity*. The learning activities we design and study, target the professional identity of apprentices as a bundle of multiple roles (as student, as apprentice in X, as worker in X, as employee/member of Y…). We noticed for example that professional membership ("I work for Nestlé") is salient. Our empirical phase provided us with interesting examples of situations where students are proud to state their identity in this way.

1.2. Situation

The 3 projects of this leading house started by a phase of observation which is reported in the project specific sections below. These observations included visits to schools, to companies and to corporate associations. We met the teachers, the students at their workplaces or in their class, their work supervisors and the trainers in professional associations. Our questions and observations focused on our main hypothesis: technologies to bridge the school-company gap. These visits revealed the complexity and variety of the Swiss vocational training system. However, despite this diversity, we repeatedly observed what we hereafter refer to as the "*skills gap*", i.e. the difference between the school objectives, officially defined by xxx, and the skills that apprentices are actually expected to acquires by their work supervisors. We observed car mechanics who do not much else than changing tires, dental assistants limited to cleaning the tools and logisticians who scan the bar codes of boxes that are stored & retrieved by automated systems. It is normal that novices practice these basic skills but actually the opportunity to move towards more elaborated skills seems less a matter of time than a matter of context: depending on the dentist, on the garage needs or on the warehouse organisations, students will or will not move on.

The reasons why more elaborated skills are not practiced as often as they should are multiple: 1) liability (e.g. what happens if an apprentice damages an expensive car?); 2) automation (e.g. the choice of the storage locations is managed by the system); 3) time (e.g. it would take too long to train the apprentice to do this); 4) organisation (e.g. there is nobody else devoted to low level tasks) and 5) social status (e.g. elaborated skills are for people higher in the hierarchy). This 'skills gap' varies between companies (e.g. see project 3), which does not facilitate the teachers' job.

Learning is a meaning making process. It is hence to expect effective learning if students practice skills at school that do not make real sense in their workplace. The three projects explore different scenarios that tackle the skills gap by providing opportunities for the cross-fertilization of school activities and work experiences. These activities are focused on school time, since this is the place where we can reach simultaneously 20 apprentices, but they foster reflection on their workplace activity. This analysis phase, discussed in details with the members of our advisory board, is now leading to a phase of design which is further described for each project.

Overview

Project **1** (Car mechanics) Prof. Gurtner, Matthieu Calame and Diego Corti, Université de Fribourg,

Project **2** (Dental assitants) Prof. Mireille Bétrancourt, Prof. Daniel Schneider, Monica Gavota, Urs Richle and Jue Wang, TECFA – Université de Genève

Project **3** (Logistics managers) Dr. Patrick Jermann, Guillaume Zufferey, Pierre Dillenbourg and a collaboration with IFFP (Institut Fédéral des Hautes Etudes en Formation Professionnelle) CRAFT- Ecole Polytechnique Fédérale de Lausanne

Prof. Pierre Dillenbourg is coordinating the leading house activities.

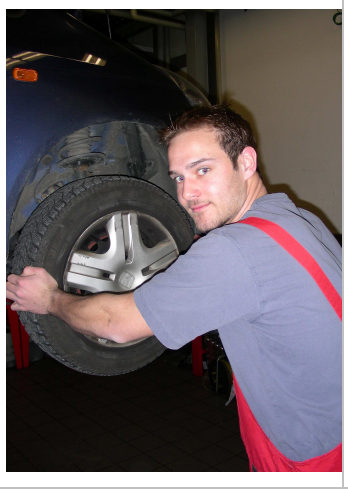
2. Project 1: Université de Fribourg

2.1. Work progress

In this project, ICT is investigated under its potential to enlarge the communication possibilities that apprentices can have with peers, with professionals and/or with their teachers, both on-line and remote. In doing so, this project primarily tackles issues 1, 2 and 3 of our general approach to ICT in vocational education. The questions which guided the reflections here were the following: 1) Does technology offer interesting ways for apprentices to receive remote help when they cannot have it directly from their co-workers? 2) Does the feeling of being able to receive "just-in-time" help foster the development of autonomy and self-regulated learning among the apprentices? As indicated in the proposal, these main questions lead to four preliminary questions:

- What kind of problems do apprentices encounter at the workplace and at school?
- What kind of help do they need in the workplace and at school
- Where from do they receive help at the workplace and at school?
- What kind of help do they ask for as they become more competent?

To answer these questions, we have gone two ways:



- Interviews and observations school have been carried on in the school setting with 12 apprentices about the "strategic", self-organisation problems they were facing while doing their homework. From these interviews it is obvious that most apprentices lack the strategic skills to do their homework alone effectively. To overcome this difficulty, the school offers the opportunity to come at school for an extra morning per week in order to do their homework under the supervision of an expert teacher. Concurrently, some supervisors at the workplace also tend to help their apprentices to go over their school homework during working hours.
- Series of one-hour recordings have been conducted with apprentices at their workplace, during which they were stimulated to comment and reflect over what they were currently doing. We have so far analysed the content of 16 one-hour sessions, with 7 apprentices, in the year 1 to 4 of their training program. Observations made are detailed in section 2.3.

← *Figure 1 Pictures taken during our interviews in garages.*

At present, we are collecting and analysing more such recordings, in order to have both more apprentices involved and longer series with the same apprentices. Concurrently, particularly interesting situations, in which apprentices were facing specific difficulties have been extracted from these interviews and presented to teachers and to the head of the vocational school with which we are in regular contact (CIFOM, Le Locle). They have expressed their interest to work on them with their own students both to illustrate what can really happen on the workplace and to set up training activities in problem solving skills adapted to specific contexts. We currently set up an interactive catalogue of these episodes to be used at school. This development will allow our project to also tackle issues 4 and 5 of the leading house's general framework.

2.2. Theoretical and methological issues

Recent theoretical developments and research indicate that help-seeking can be an important self-regulated learning strategy (e.g. rehearsal, organization, and elaboration) and can improve knowledge and skill acquisition (e.g. see Butler, 1998 ; Karabenick, 2004). Most of the research on help-seeking though has up to now been conducted within school contexts. Focus of such research has primarily been the teacher's behavior (Karabenick & Sharma, 1994 ; Newman & Schwager, 1993), the classroom goal structure (Ryan, Gheen & Midgley, 1998) or cooperative learning groups (Webb & al, 2006). Only little attention has been put to help-seeking behaviours in practical and workplace situations (e.g. Lee, 1997; 1999) which is the focus of this project.

Our method is the following. Once a week during 8 weeks, we call apprentices and ask them to verbalise their thoughts and feelings out loud during their work at the garage. We listen to what they say and intervene only when apprentices do not spontaneously comment on a specific difficulty or problem they encounter. By doing so, we intend to foster apprentices' ability to *articulate* what they are currently doing and *reflect* on the kind of problems they may encounter at work.

Each session is recorded and transcribed (using a software tool called TRANSANA). Transcripts are then carefully analyzed, in search for "critical events" in which problems were encountered and help-requests are formulated. Since records are available from each apprentice over periods as long as 8 weeks, we are now able to follow the development of their reasoning over time; we intend to examine these developments in order to see whether improvements can be noticed between earlier and later problem descriptions, solutions set up and type of help requested.

2.3. Preliminary results

As we mentioned previously, the first phase of our project consists in understanding the types of problems an apprentice generally faces during his work and what kind of help he needs. We are currently analyzing the phone call records. We track down any situations in which apprentices encounter a problem. A problem is defined rather broadly as anything that prevents the intended procedure to proceed smoothly and implies from the part of the apprentice a reflection on what he should do next.

For each problem, we observe whether the apprentice seeks help or not. 'Help-seeking situations' are defined as situations where apprentices require information, the contribution or the assistance of another person of the work team. We not only consider situations where apprentices seek help because they are facing an unexpected problem, but also situations in which they do not seem to have a problem but ask somebody for help. A special attention is devoted to the questions apprentices decide to ask, and the kind of help they expect to get. Various types of questions and requests for help are observed at the workplace, as shown in figure 2.

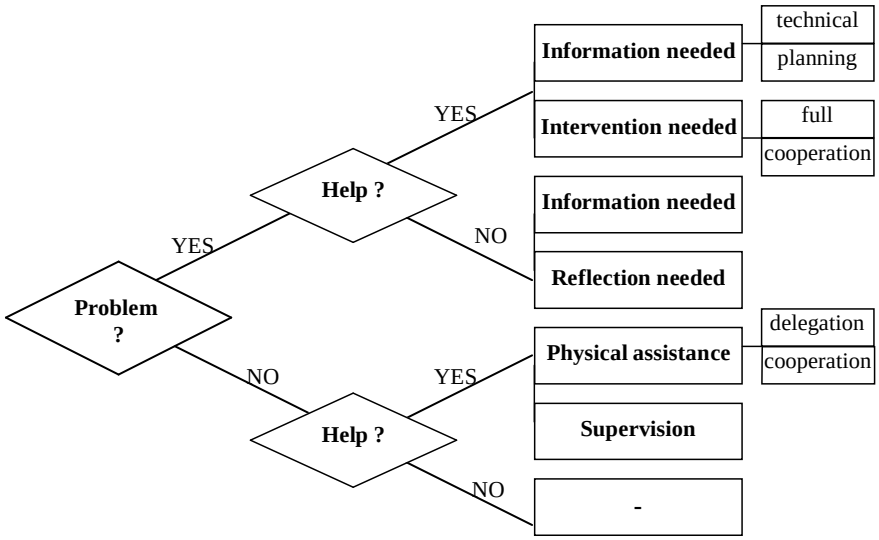


Figure 2: Decision tree at the workplace and types of help expected.

Here are some examples that illustrate these different types of help requests:

Example 1: Problem ➔ help requested ➔ *information needed* ➔ *technical*

- I have to ask something to my colleague:
- The bolts for alu'wheels, the XL, are they the same as those for steel'wheels?
- …
He is not sure, I prefer to be sure, so I just ask the boss because we never know… - - Listen… for the bolts of 807'wheels, are they the same bolts?
- It is alu…
- OK.
I prefer to be sure, it is always better … because sometimes we have misfortunes"

Apprentice 4

Example 2: Problem ➔ help requested ➔ *intervention needed* ➔ *cooperation*

"Now, I just want to ask my colleague how I have to purge. (…) As I said before, it is necessary to purge the cooling circuit. If we don't make it, air infiltrates in the engine. But there are several points to purge the cooling circuit and, in fact, I did not know where these points were. So I asked my colleague and he came to show me how to do it."

Apprentice 2

Example 3: No Problem ➔ help requested ➔ *physical assistance* ➔ *cooperation*

"I just ask an apprentice to help me to check the lights.
- Could you check the lights?
- Yeah,.. yeah, fog's lights, horn, yeah…, flashing indicators,…
OK, thank you."

Apprentice 4

We also analysed to whom help requests are addressed and how this help is given. While some types of help requests require "proximal" intervention, others can be solved by "distal" assistance of the person to whom the help request has been directed. We define as *proximal help* any kind of assistance for which the helper had to interrupt his own activity and move to the location where the apprentice is. *Distal assistance* on the

contrary can be provided without physical transportation of the helper. We are currently trying, on the basis of the phone call records, to see if regularities appear between the types of problems, the type of help-requests, the persons to whom they are addressed and the type of help provided. The following trends are already visible:

- In contrast to class contexts, where the helper is almost always the teacher, in the workplace there are many potential helpers. An apprentice learns to address his help-request to dedicated persons according to the kind of help he needs.
- In contrast to school context also, mistakes are not tolerated at the workplace. Making mistakes is therefore worse than asking help when not needed. As a result, only few problems encountered are not followed by any help-requests and supervision requests are sometimes addressed even if one knows how to perform the activity.
- Nevertheless, apprentices sometimes try and solve their problems by themselves, especially when the person from whom help is expected is not around

3. Project 2: Université de Genève

3.1. Work Progress

Project 2 focuses on apprentices in the health sector and particularly dental care assistants. It investigates how ICT can support experienced-based and project-based learning scenarios to improve integration between school and workplace training. On the basis of analyses conducted during this first year, we focused our investigation on writing and reflecting about one's experience, i.e. events experienced in the workplace. Initial accounts of situations and events are digital objects that can be used to engage students in reflective and collaborative knowledge building activities. The underlying hypothesis is that sharing and processing with other students may enhance both domain and strategic knowledge and finally foster professional identity (Wenger, 1998).

In agreement with the design based research approach (Collins, 1992) and in order to propose learning environments that are relevant to the context, the first year was mainly devoted to the analysis of the apprentice's learning environment and to early field tests. Our main lines of investigation are the following:

- What does the training at school and the workplace entail? How do these two training places interact?
- What are the characteristics of the apprentices in this sector? How do they experience work and school activities?
- What are the main tasks of dental care assistant and their interactions with co-workers? How do they construct their professional identity?
- How do both apprentices and school teaches cope with ICT environments that could support writing and knowledge construction activities?
- In which situations may ICT-enhanced collaborative writing-to-learn scenarios be most profitably introduced?

For the first question, we conducted interviews with the school teaching team, including practitioners who teach professional subject matters, and we carried out both class and dental cabinet observations. We identified the main characteristics of school activities, workplace training and also the areas in which writing-to-learn activities could bring an added value.

For the second question, we conducted semi-structured interviews with a sample of second year apprentices about their training background and experience, their attitude towards the apprenticeship at school and in the workplace and their use and attitude towards ICT (personal, professional and learning uses). Based on these interviews, we then administered a survey questionnaire to the whole second year population. Finally, we administered to the same apprentices the "Writing Apprehension Scale" (Daly & Miler, 1975) and the "Writing With a Computer Scale" (Shaver, 1990) tests.

For the third question, we conducted observations in a dentist cabinet, as well as interviews with the apprentices and the certified dental assistants working there. We obtained a preliminary description of the tasks that are carried out by the apprentices and their characteristics (frequency, difficulty, importance…). We identified several issues related to professional identity (including problematic issues regarding some of the apprentice's role as worker, work placer learner and school learner). This first grid will be completed by way of further observations in different types of cabinets.

To answer the fourth question, we designed in close collaboration with teachers some learning activities using computers. We first introduced the web platform and simple writing activities during the general classes (IT, English). The goal of these preliminary activities was to introduce computer supported writing application to the teachers and the apprentices, to observe the reactions of the participants in order to get a reference point for future activities to be co-developed with the school.

From a technical point of view, it should be mentioned that the school had no technological infrastructure. The two classrooms were equipped with a few operational network outlets, but there were no computers for students. Our suggestion to the school management was to provide 10 laptops that could be moved across the two classrooms in order to integrate "normal" teaching activities with computer-enhanced activities and to connect them to the Internet over a Wi-Fi (wireless) in order to achieve maximal mobility. The installation of the Wi-Fi at the school required negotiations with the authorities in charge of ICT in Geneva schools: CTI (Centre of the Technologies de l'Information) and SEM (Service Ecole Media). The computers have been installed and are in use in the classroom since March 2007.

We currently are tackling the fifth question in two directions: In order to design ICT-enhanced collaborative writing-to-learn scenarios we conduct interviews and design sessions with teachers and we are in the process of analyzing results from pilot scenarios conducted in IT and English classes. We identified a number of critical skills (e.g. radiography, accounting, interpersonal relations) that should benefit from enhanced learning designs.

In the context of this project, we raise two research hypotheses of fundamental relevance and add a more practical design-oriented question:

- First, we assume that promoting activities involving writing about one's practical experience at the workplace and reusing it in school context will improve *articulation* between school and workplace training. This articulation should engage apprentices in more reflective and grounded knowledge building, thus contribute to a better learning effect, in particular of difficult subject matters.
- Second, we expect that such a *knowledge building community* design (Scardamalia & Bereiter, 1994b) will promote the construction of a *professional identity* (Wenger, 1998).
- A third research question deals with the technical design of an *ICT-based* learning environment that optimally supports various pedagogical scenarios that include exchange on experiences, reflective activities, and collective building of knowledge.

3.2. Theoretical and methological issues

These working hypothesis and research questions are considered from three complementary perspectives: writing-to-learn, community of practice for professional development, and computer-supported tools for the collaborative knowledge building. As stated in our research proposal, we follow the "Writing-to-learn" approach (Klein, 1999; Galbraith, 1999) that mostly focused on the effects of individual writing and related cognitive issues. We therefore will investigate in which conditions writing activities can promote acquisition of knowledge or skills in the particular context of apprenticeship.

While mainstream "writing-to-learn" research focuses on the production of larger texts or self contained entries, writing in a CSCL perspective rather concerns producing short texts in various genres (questions, arguments, definitions, etc.). In this research, we focus on "restructuring learning environments" (Flower & Hayes, 1984; Erkens et al. 2003) where the main hypothesis is that knowledge transformation leads to knowledge constitution (Galbraith, 1999). In addition, when writing contributes to a larger collective body of knowledge whose elements can be edited, manipulated and put in relation we refer to so-called computer-supported intentional learning environments (CSILE/Knowledge Forum) (Scardamalia & Bereiter, 1994). Scenarios associated with that kind of learning environment aim at *articulation* and *reflection*. In other words, they reframe the classroom discourse to support reflective knowledge building in ways extensible to out-of-school knowledge.

Many scholars investigate the dynamics of communities of practice in professional development. By exchanging experience, the community fosters the emergence of innovative practices and professional identity (Wenger, 1998 ; Daele & Charlier, 2006). In our project, we assume that restructuring and knowledge building can be enhanced through computer-supported "knowledge building communities". Writing in school about one's actual experience in the workplace will make school education more situated. Conversely, collective elaboration and discussion about the apprentices experience will enrich and reframe workplace training. Wenger's identity concept may be a key element to think about integration of workplace and school learning. Learners must cope with their identity as a learner in school, as a learner in the workplace and as a practitioner in the workplace. In addition they need to master professional roles. E.g. a dental care assistant must provide assistance to dental surgery, manage patients, do some office work, clean surgery tools, etc. In conclusion, we should favor *identity* development with respect to all expected roles.

From a methodological point of view, we apply standard methods for the analysis of the context: semi-guided interviews with the actors (teachers, trainers in the workplace, apprentices), observation of classroom and workplace activities. We apply survey techniques to measure apprentice's writing apprehension and to triangulate results from observations and interviews. As for the design of the computer-supported environment, we adopted a user-centered iterative design approach and first proposed a very basic tool to support initial pilot activities. We will progressively add new functionalities according to new learning activities designed in close collaboration with the teachers. In later phase, we will investigate in a similar way the design of new functionalities that would make the tool usable in the workplace and we also plan to introduce experience sample methods.

3.3. Preliminary results

Attitude towards writing with the computer. The results from the writing apprehension scale showed that most students do not apprehend writing activities (average of 16 on a scale up to 25). Seven students showed a low level of apprehension and only 2 a high level of apprehension. A factor analysis revealed two main factors: the apprehension

towards writing act and the evaluation. Apprentices apprehend more the writing act per se than the evaluation of their written productions. The results from the apprehension scale towards writing with a computer showed mostly positive attitudes. We also found that the students appreciate the enjoyability of computer writing more than its usefulness. Such analysis provided useful information to appreciate the feasibility of introducing writing activities.

Semi-directed interviews and questionnaire. Results from interviews with 10 apprentices and the questionnaire administered to all second year students showed a rather heterogeneous population. Here, we just present three salient descriptive results. Firstly, prior training is not the same (e.g. some started another apprenticeship before) as well as career plans. Second, work tasks and tutoring support varies widely across cabinets. Accordingly, our population has very different skill levels. Third, most apprentices do have access to a computer at home, but only about half at work. Currently we are discussing how to design learning scenarios where different types of apprentices could profit from each other, in particular how dental care apprentices with a more advanced professional identity could help others to improve theirs (including associated skills).

Preliminary learning activities. Some preliminaries writing activities have been conducted in general classes (i.e. IT class and the English class). Students were asked to use the web platform to report on a difficult, problematic situation they experienced at work in the dentist cabinet. They were then instructed to comment on at least one student's entry. The explicit goal of this first activity was to familiarize the teachers and the students with the writing application - the collaborative platform - and to observe how an experience sharing exercise would be achieved by the students. The students were not reluctant to write about their experience. They mostly reported difficulties regarding interpersonal relations with colleagues and clients in the cabinet. Difficulties regarding skills and knowledge came second. From a technical point of view, they did not experience difficulty in using the blog-like tool to enter the experience, or to comment on other's experiences.

Technological aspects. In order to find adequate solutions for the implementation of writing-applications in the context of the vocational training, we firstly made an inventory of existing writing tools. The individual applications and platforms were tried out and evaluated regarding objectives of our project and the previously described

collected data. We then selected the ELGG "social software" platform (www.elgg.org) and made some adaptations. It offers functionalities like: Journal (Blog), comments, document management system, community building (sharing of relationships), RSS-feeds, profile-definition. These tools provide a substrate for E-Portfolios and knowledge community building. The platform was adapted to the specific needs of initial scenarios. We presently work with a simplified variant of the platform, with the aim to familiarize both students and teachers with an-online writing environment and to study initial productions and interactions. Gradually we will add functionalities to support learning activities co-designed with teachers and trainers.

Change management issues. While our research does not focus on change management, there are issues we have to address. Pedagogical approaches based on concepts like ICT-enhanced teaching and knowledge-building communities are transformative of professional identities and therefore require carefully planned engagement in expansive organizational learning (Engeström, 1996). One of the reasons we started conducting field experiments with peripheral courses (like IT and English) was the need to construct early experiences as objects for further negotiations with core subject teachers and school leadership.

3.4. Remarks

Due to recruitment delays, project 2 started a bit later than planned. The full-time PhD student started her work on September 1st 2006.

4. Projet 3: EPFL

4.1. Work progress

We report here the activities that took place during the first year of the project. Results stemming from these phases are presented later under point 4.2 and 4.3.

Initial observations phase (April 2006 to September 2006)

During the first five months of the project we conducted a qualitative study of the logistics apprenticeship program. The study included interviews of all relevant institutional actors (school, professional association, companies):

- We established contacts with the director and two logistics teachers of a professional school (CPNV, Centre Professionel du Nord Vaudois, Yverdon). Several meetings were conducted: we explained the project's aim to the teachers and in return got an overview of the logistics' program.
- We conducted observations for three full days at the practical school run by the corporate association (ASFL, Association Suisse pour la Formation Professionelle en Logistique, Marly).
- We visited a dozen companies employing logistics management apprentices. The visits started with a guided tour of the company led by the apprentice himself. We then conducted a semi-structured interview with the apprentice and finally had an open discussion with the apprentice's supervisor ("maître d'apprentissage").

The qualitative study led to the identification of a central problematic in the training of logistics apprentices to which we refer to as the "skills gap":

- School is too theoretical, and thus apprentices face problem when it comes to understand logistics concepts,
- At the workplace apprentices rarely have the opportunity to practice the managerial skills they are taught in school.

First Design Phase (from October 2006 to February 2007)

After this initial study, we started a design phase in close collaboration with two teachers from CPNV. The design concerns both pedagogical and technical aspects of the project. The approach we propose to bridge the gap is to anchor the construction of conceptual knowledge in concrete activities. More precisely, we propose a game-based learning approach, in which the apprentices acquire conceptual understanding by playing with a tangible simulation based on a small scale model of a warehouse. This model is composed of a table on which apprentices move miniature shelves to create a custom warehouse as well as remote controlled forklift robots. Logistics concepts are illustrated by the projection of feedback on top of the table from a ceiling mounted beamer.

4.2. Theoretical and methodological issues

Articulation of school curriculum and workplace practice

Logistics consists of the management of two concurrent flows: the physical flow (moving goods) and the information flow (keeping track of the goods, managing the stock). Activities within each flow can be accomplished by machines and computers to varying degrees. Based on the observations of the twelve companies that we visited, we propose four types of work distribution (see table 1). Most companies correspond to types 2 and 3 and only few to types 1 and 4. The table describes the 2 flows:

- *Information flow*. School curriculum addresses concepts about the management of the information flow, but in many companies, this aspect of logistics is completely taken over by computers. Moving down the rows in table 1, the more sophisticated the warehouse, the less humans control the management of information. Employees do (can) not decide why a box is stored at a given place, in what order goods should be moved out of the storage, when new items should be ordered, how many items have to be ordered. They hence are somewhat de-skilled.
- *Physical flow* Apprentices' main activities are often restricted to the physical flow. The responsibilities for managing the warehouse, when this activity is at all performed by humans, are assumed by the person in charge of the warehouse.

	Flow	
	Information	Physical
1. Humans only	H	H
2. Computers supporting humans	H + C	H
3. Computers controlling humans	C	H
4. Computers controlling machines	C	C + H

Table 1: Distribution of logistics management between humans (H) and computers (C)

Teaching conceptual knowledge in schools is difficult due to the aforementioned problems. Apprentices have to bridge the gap from physical manipulation (focus of the workplace) to abstraction and information management (focus of the school). The aim of this project is to explore how educational technologies can support this transition.

The last decade revealed an evolution of computer science towards more physical interactions between the users and the tools. Information technology is not anymore bound to desktop or laptop computers. *Dissapearing computing* refers to the fact that the form factor of computers does not correspond to large boxes on a desk anymore, but that computers tend to move to the background. '*Tangible interface*' refers to input devices which replace the traditional keyboard and mouse with objects that can be manipulated by the users. *Augmented reality* refers to the overlay or digital information on top of real objects.

Simply put, these technologies allow for more a concrete and physical interaction with computers compared to traditional desktops. This new type of interface matches the apprentices' daily focus on concrete activities very well. We hypothesize that apprentices will be more effective doing a warehouse design exercise by moving physical shelves on a table compared to drawing a plan of the warehouse, calculating surfaces and proportions. The calculations still are part of the curriculum, and will be addressed in a second step. The difference with a traditional school approach is that concepts are first illustrated by practical exercises.

Regarding to methodological issues, we chose to carry out interventions in schools rather than in companies because of three practical considerations. First, acquiring information management skills is much more a goal for schools than for companies. Second, the efficiency of school-based interventions is greater as we reach 20 students at once. Third, fewer negotiations have to be conducted when introducing innovations in schools compared to companies. The next steps in our design-based approach consist of testing the material in a real setting (June 2007) and collect feedback. A second iteration of design will then follow during summer 2007.

4.3. Preliminary results

Results so far consist of the analysis of the situation and the development of a potential solution in collaboration with logistics teachers.

Reflection grounded in practice

The choice of a physical setting (small scale model on a table, input through physical manipulation, simulation output as movements of robots) allows us to start from the concrete situation apprentices encounter everyday (i.e. a real warehouse). The progression towards more conceptual activities will be implemented by successive transformations of the environment from the concrete level (physical small scale model) to the figurative level (warehouse simulation, no physical robots) to the abstract level (no warehouse analogy, simulation of processes and underlying variables). The transition from one level to the other might include intermediary steps that are still under discussion.

The overall scenario for the game-based approach is modelled after the roles in the career of an apprentice, from being a forklift driver (physical flow), to being a warehouse designer and eventually a warehouse manager (information flow). Activities are depicted as circles in Table 2. The sequence of activities implements a progression through roles as well as through representational levels.

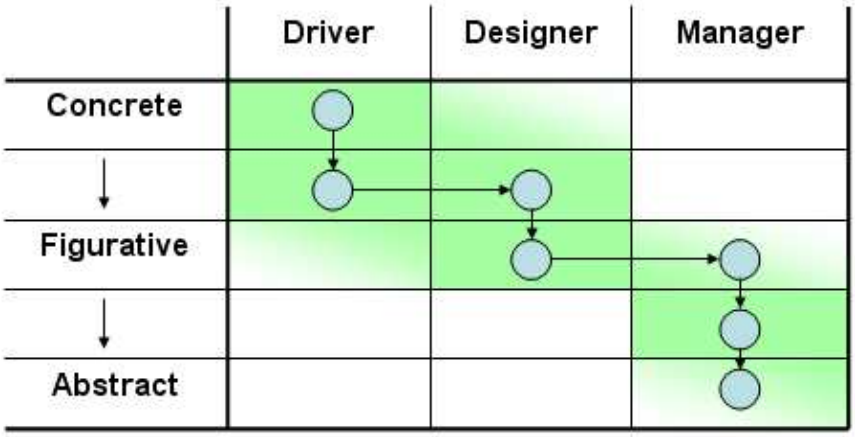


Table 2: Progression from concrete tangible interaction with warehouse components to abstract annotations of graphical representations.

To illustrate the progression we provide a short example for each of the roles:

- Concrete – Driver: Apprentices have to exercise the concept of "double-jeu" which consists of minimizing the forklift's movements without a charge. The initial situation consists of 1) three pallets that have to be enterer into the warehouse from the arrival dock and 2) three pallets that have to leave the warehouse through the departure dock. The task consists of choosing the ideal path of the forklift(s) by drawing with dry-erase markers on the floor of the warehouse.
- Designer – Concrete/Figurative: Apprentices have to understand the implication of the type of goods (perishable or not) upon the physical layout of the warehouse, i.e. they have to choose between several short alleys (faster picking, more space lost for alleys), few long alleys (slower picking, less space lost). Apprentices arrange physical small-scale shelves on the table and the ceiling-mounted projector shows the possible paths that can be taken by forklifts (or the mean time needed to access any point from the dock, or other relevant variables) on top of the model.
- Manager – Abstract: Apprentices have to determine the minimum inventory at which an item has to be reordered. The simulation now displays a list of items, inventory and ordering information. A line chart of past inventory levels is displayed on the table. Apprentices either draw a horizontal line on the chart that represents the minimal inventory level or draw arrows to represent ordering time.

We also started the development of the technical infrastructure that will be used in schools. We developed a small scale (1:16) forklift robot based on electronic and mechanic components available on the market. The robot is remote-controlled via a radio link with the computer. A fiducial marker (black and white pattern in figure 3) allows a camera to track the position and orientation of the robot on the table.

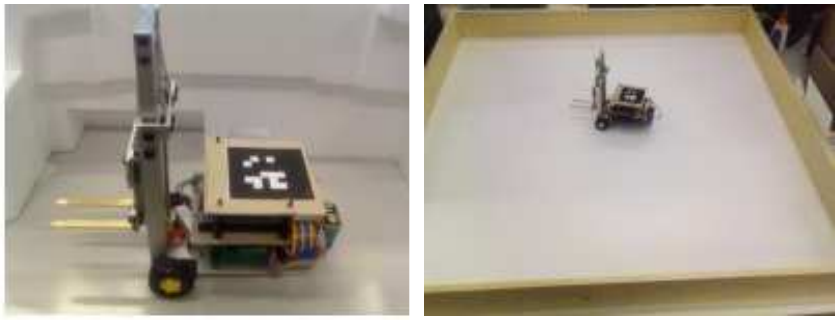


Figure 3: Remote controlled forklift with a fiducial marker (left) on first table (right).

At the time of writing, we are implementing the tracking technology that allows detecting the positions of the shelves and the robots with a ceiling mounted camera. We use existing augmented reality software (ARTag) that allows a camera to identify and position fiducial markers (see figure 4).

Figure 4: Left: ceiling mounted camera and beamer. Right: fiducial markers as recognized by ARTag (images from http://www.artag.net/).

5. Other projects

The leading house proposed a theme for launching a call for proposals for the 4th project. The theme has not been accepted by the steering committee. A new theme has been proposed by the members of the advisory board.

6. Training young researchers scientists

6.1. Young researchers

	Name	*Activities*
1	Matthieu Calame Université de Fribourg	Projet 1 + PhD in Education
2	Monica Gavota Université de Genève	Projet 2 + PhD in Education
3	Guillaume Zufferey EPFL	Projet 3 + PhD in Computer Science
4		

During this first year, the young scientists and the senior members of the leading house met 12 times, i.e. every month:

- We had 8 regular projects meeting where we discuss the activities of the leading house but especially each project;
- We had an internal training event (Nov. 8th 2006), a one day course on qualitative data analysis methods, given by Pr. Schneider (Université de Genève) and Dr. Jermann (EPFL)
- We had two external training events. Dr. Hilde Van Keer (University of Ghent, Belgium) gave a two-day course (September. 13th 2006) for our PhD student on multi-level statistical analyses. These methods are important since the unit of our studies is not the individual but we have multiple units (individuals, groups, class).
- All PhD students participated to the quick-off meeting (Nov. 8th 2006) attended by some of the leading house partners: schools, companies, corporate associations and IFFP.
- All participants participated to the 2.5 days residential seminar (Villars, Jan. 24th – 26th 2007) with all leading house members, the members of the advisory board and some guests.
- G. Zufferey followed the course "Distributed cognitive systems" given by P. Dillenbourg within the programme of the EPFL doctoral school in computer science.
- M. Calame participated in the seminar organized in Fribourg by the doctoral program in education last January on Vocational education in Europe: contrasting approaches and models for a same purpose.

6.2. Travaux en cours

G. Zufferey has recently submitted his PhD proposal at EPFL

6.3. Articles, publications

See section 8

7. Overview of year 1 activities

7.1. Project 1

- Recruiting of PhD student and other collaborators [February-March 2006]
- Organization of the setting within the school [April-May 2006]
- Observations and interviews within the school [May-June and September 2006]
- Discussions with UPSA in order to select garages [August-October 2006]
- Invited adress for teachers and schooldirectors SWISSMECHANIC [Nov.9.2006]
- Contacts with garage directions and apprentices [October-November 2006; February-March 2007]
- Recordings in garages [November 2006 - February 2007]
- Selection of critical episodes [January - February 2007]
- Presentation of critical episodes to the school teachers and authorities [March 2007]

7.2. Projet 2 – à mettre preferablement en ordre cronologique

- Discussion with school leaders [June 2006 - January 2007]
- Interviews with dentists [June - September 2006]
- Writing apprehension tests [November 2006]
- Cabinet visits [December 2006]
- Field Test (learning scenario) 1 [December 2006]
- Interviews with apprentices [January 2007]
- Field Test (learning scenario) 2 [February 2007]
- Survey [February 2007]
- Field Test (learning scenario) 3 [March 2007]
- Field Test (learning scenario) 4 [March 2007]

7.3. Projet 3

-

7.4. Events

- 8 internal working meetings
- 3 training events (see section 6.1)
- A quick-OFF meeting at EPFL, on November 8th 2006, with some of our partners in schools, companies and corporate associations
- A one day meting with the researchers from the Lausanne (sepetembre th 2006) , Lugano and Zollikofen centers of IFFP (Institut Fédéral des Hautes Etudes en Formation Professionnelle).
- A 2.5 days residential seminar (Villars, Jan. 24th – 26th 2007) with all leading house members, the members of the advisory board and some guests. This workshop was integrated within a week of independent workshops ON CSCL, hold in the same place.

8. Publications

Since this was the first year of this project, only one paper that directly relates to this work. Has been published by project 1.

Gurtner, J.-L, Calame, M. & Corti, D. (accepted). Seeking help over the mobile phone: a solution for novices at work ? EARLI 2007, Budapest.

9. Bibliography

Butler, R. (1998). Determinants of help seeking: Relations between perceived reasons for classroom help-avoidance end help-seeking behaviors in an experimental context. *Journal of Educational Psychology, 90*, 630-643.

Collins, A. (1992). Towards a Design Science of Education In E. Scanlon & T. O'Shea (eds.), *New Directions in Educational Technology*. Berlin: Springer Verlag.

Daele, A. et Charlier, B. (Eds.). (2006). Comprendre les communautés virtuelles d'enseignants: Pratiques et recherches. Paris :L'Harmattan.

Daly, J. A., & Miller, M. (1975). The empirical developement of an instrument to measure writing apprehension. *Research in the Teaching of English*, 9, 242-249.

Dillenbourg, P. & Jermann, P. (2007). Designing integrative scripts. In F. Fischer, H, Mandl, J. Haake & I. Kollar (Eds) *Scripting Computer-Supported Collaborative Learning – Cognitive, Computational, and Educational Perspectives*., pp. 275-301. Computer-Supported Collaborative Learning Series, New York: Springer

Engeström, Y (1996), Developmental work research as educational research". *Nordisk Pedagogik* 16 (3) 131-143.

Erkens, G., Kanselaar, G., Prangsma, M., & Jaspers, J. (2003). Computer Support for Collaborative and Argumentative Writing. In E. De Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (eds). *Powerful Learning Environments: Unravelling basic components and dimensions* (pp. 157-176). Amsterdam: Pergamon, Elsevier Science.

Flower, L. & Hayes, J. R. (1984). Images, plans, and prose: The representation of meaning in writing. *Written Communication* 1: 120-160.

Galbraith, D. (1999). Writing as a knowledge-constituting process. In M. Torrance and D. Galbraith (eds.), *Knowing What to Write: Conceptual Processes in Text Production* Amsterdam: Amsterdam University Press. (pp. 139-160).

Karabenick, S. A. (2004). Perceived achievement goal structure and college student help seeking. *Journal of Educational Psychology, 96*, 569-581.

Karabenick, S.A. & Sharma, R. (1994). Perceived teacher support of student questioning in college classrooms: Its relation to student characteristics and role in the classroom questioning process. *Journal of Educational Psychology, 86*, 90-103.

Klein, P.D. (1999). "Reopening Inquiry into Cognitive Processes in Writing-To-Learn", *Educational Psychology Review, 11* (3), 203-270.

Lee, F. (1997). When the going gets tough, do the though ask for help? Help seeking and power motivation in organizations. *Organizational Behavior and Human Decision Processes, 72*, 336-363.

Lee, F. (1999). Verbal strategies for seeking help in organizations. *Journal of Applied Social Psychology, 29*, 1472-1496.

Newman, R. S., & Schwager, M. T. (1993). Students' perceptions of the teacher and classmates in relation to reported help seeking in math class. *The Elementary School Journal, 94 (1)*, 3-17.

Ryan, A. M., Gheen, M. H., & Midgley, C. (1998). Why do some students avoid asking for help? An examination of the interplay among student's academic efficacy, teacher's social-emotional role, and the classroom goal structure. *Journal of Educational Psychology, 90 (3)*, 528-535.

Scardamalia, M. & Bereiter, C. (1994). The CSILE project: Trying to bring the classroom into world. In K. McGilly, ed., *Classroom Lessons: Integrating Cognitive Theory and Classroom Practice* (pp. 201–228). Cambridge, MA: MIT Press/Bradford Books.

Scardamalia, M. (2003). Knowledge Forum (Advances beyond CSILE). *Journal of Distance Education*, 17 (Suppl. 3, Learning Technology Innovation in Canada), 23-28.

Scardamalia, M., & Bereiter, C. (1994b). Computer support for knowledge-building communities. The Journal of the Learning Sciences, 3(3), 265-283.

Shaver, J.,P. (1990) Reliability and validity of mesures of atitudes tword writing and tword writing with computer. *Written communication*, Vol 7, No 3, 375-392.

Webb, N. M., Ing, M., Kersting, N., & Nemer, K. M. (2006). Help-seeking in ccoperative learning groups. In K. S. A. & R. S. Newman (Eds.), *Help seeking in academic settings. Goals, groups and contexts* (pp. 45-88). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Wenger, E. (1998). *Communities of practice Learning, meaning, and identity*. Cambridge: Cambridge University Press.

10. Appendix (project 2)

This appendix contains three instruments that we used to study the population:

- The first questionnaire ("Writing Apprehension Test") investigates the attitude of the apprentices toward the writing in general.
- The second questionnaire ("The Attitudes Toward Writing With a Computer Scale") investigates the attitude of the apprentices toward the writing with a computer.
- The third questionnaire investigates several aspects concerning the profiles of the apprentices, their attitudes towards school, work, technologies, the functioning of the cabinet, etc.

10.1. "Writing Apprehension" Test

Writing Apprehension Tes

Below are a series of statements about writing. There are no right or wrong answers to these statements.Please indicate the degree to which each statement applies to you by circling whether you (1) strongly agree, (2) agree, (3) are uncertain, (4) disagree, or (5) strongly disagree with this statement. While some of these statements may seem repetitious, take your time and try to be as honest as possible. Thank you for your cooperation in this matter.

	1	2	3	4	5
1. I avoid writing.					
2. I have no fear of my writing being evaluated.					
3. I look forward to writing down my ideas.					
4. I am afraid of writing essays when I know they will be evaluated.					
5. Taking a composition course is a very frightening experience.					
6. Handing in a composition makes me feel good.					
7. My mind seems to go blank when I start to work on a composition.					
8. Expressing ideas through writing seems to be a waste of time.					
9. I would enjoy submitting my writing to magazines for evaluation and publication.					
10. I like to write my ideas down.					
11. I feel confident in my ability to clearly express my ideas in writing.					
12. I like to have my friends read what I have written.					
13. I'm nervous about writing.					
14. People seem to enjoy what I write.					
15. I enjoy writing.					
16. I never seem to be able to clearly write down my ideas.					
17. Writing is a lot of fun.					
18. I expect to do poorly in composition classes even before I enter them.					
19. I like seeing my thoughts on paper.					
20. Discussing my writing with others is an enjoyable experience.					
21. I have a terrible time organizing my ideas in a composition course.					
22. When I hand in a composition I know I'm going to do poorly.					
23. It's easy for me to write good compositions.					
24. I don't think I write as well as most other people.					
25. I don't like my compositions to be evaluated.					
26. I'm no good at writing.					

10.2. "The Attitudes Toward Writing With a Computer Scale" test

The Attitudes Toward Writing With the Computer Scale (ATWCS)

1. Writing on a computer is more fun than writing with pencil and paper.
2. All students should do some writing on a computer.
3. People who write on computers become better writers than they would otherwise.
4. Using a computer to write just makes writing more difficult.
5. The students in every composition class should have access to a computer to write on at school.
6. A computer program is not likely to be of much help in revising a paper.
7. Students would learn more if they could do the writing assignments in all of their classes on a computer.
8. Learning to write on a computer is more trouble than it's worth.
9. Computer programs can be helpful in deciding how to improve a paper.

Note: Response choices are: strongly agree, agree, uncertain, disagree, and strongly disagree. Items are scored from 1 to 5, with scoring reversed for items 4, 6, and 8; the higher the score, the more positive the attitude. Total scores can range from 9 to 45.

10.3. General questionnaire

Questionnaire équivalent à l'entretien avec les élèves
Les informations que vous nous fournirez grâce à ce questionnaire seront traitées en gardant votre anonymat.
Nous vous remercions pour votre collaboration !
Marquez votre :

1. Nom :.....
2. Prénom : .....
3. Age : .....
4. Entre la fin du cycle et la rentrée, l'année dernière, à l'école d'assistantes dentaires vous avez (*plusieurs réponses possibles*) :
   - essayé un autre apprentissage
   - suivi une école d'orientation professionnelle
   - suivi une autre école
   - rien, je suis rentrée directement à l'école d'assistantes dentaires
   - autre – expliquez brièvement .....

5. Vous aimez la formation d'assistante dentaire
   - oui, beaucoup
   - oui, ça va
   - non, pas trop
   - non, pas du tout

6. Dans les cinq années qui suivront la fin de cette formation vous pensez :
   - pratiquer le métier d'assistante dentaire
   - pratiquer un autre métier
   - suivre une autre formation mais toujours dans le domaine médical
   - suivre une autre formation dans un autre domaine que le médical
   - autre- expliquez brièvement .....

7. Est-ce que vous aimez ce que vous apprenez **à l'Ecole** d'assistantes dentaire (**non pas dans le cabinet, juste à l'école**) ?
   - oui, beaucoup
   - oui, ça va
   - non, pas trop
   - non, pas du tout

8. Classez dans l'ordre vos préférences dans les matières que vous suivez à l'école (branche professionnelle, culture générale, anglais et informatique). Commencer avec votre matière préférée et finissez avec celle qui vous intéresse le moins.

1.
2.
3.
4.

9. La plus part du temps vous faites vos devoirs seule ?

oui
non

10. La plus part du temps vous faites les devoirs

quand ils ont été donnés
juste avant la date limite

11. Avez-vous un ordinateur à la maison ?

non
oui, l'ordinateur de la famille
oui mais il est a quelqu'un d'autre (père, mère, frère, copain, etc.)
oui, j'ai mon propre ordinateur

12. Avez-vous accès libre à cet ordinateur ?

oui, quand je veux le temps que je veux
oui mais les autres personne en ont besoin aussi
oui un peu
non

13. Est-ce que vous avez un accès internet à la maison ?

oui
non

14. Vous utilisez l'ordinateur à la maison pour (*plusieurs réponses possibles*):

recherches sur internet
chat (msn, messenger, etc.)
musique, films
jeux
taper des lettres
faire des devoirs

autre – expliquez brièvement ……

15. Si vous devez taper un texte sur ordinateur

vous trouvez facilement les touches, vous ne regardez même pas le clavier
vous trouvez facilement les touches mais vous devez regarder le clavier
vous passez un peu de temps à chercher les touches
c'est un calvaire, il vous faut trop de temps et d'effort pour trouver les touches

16. Combien de temps utilisez-vous l'ordinateur à la maison en moyenne par jour (**répondez seulement si vous avez un ordinateur à la maison**)?

je ne l'utilise pas tous les jours
je l'utilise moins d'une heure par jour
je l'utilise environ une heure par jour
je l'utilise carrément plus d'une heure par jour

17. Combien de dentistes, diplômé(e)s et autres apprenti(e)s (**autres que vous**) il y a-t-il dans le cabinet ou vous faites votre apprentissage ?

Dentistes :……
Diplômé(e)s :……..
Autres apprenti(e)s :……

18. S'il y a plusieurs dentistes dans votre cabinet, est-ce que vous travaillez avec

un seul d'entre eux
plusieurs

19. Est-ce que vous avez accès à l'ordinateur du cabinet?

oui
non

il n'y a aucun ordinateur dans le cabinet

20. **Si vous avez répondu « oui » à la question no 18**, est-ce qu'il y a internet sur les ordinateurs de votre cabinet ?

oui
non

21. **Si vous avez répondu « oui » à la question no 19**, est-ce que vous pouvez utiliser l'internet sur l'ordinateur du bureau ?

oui
oui mais juste en cachette
non

22. Qu'est-ce que vous faites, vous, sur l'ordinateur du cabinet (**répondez seulement si vous avez accès à l'ordinateur du cabinet**) (*plusieurs réponses possibles*)?

regarder les dossiers des patients
prendre rendez-vous
écrire des lettres
faire de la facturation
remplir les dossiers des patients
passer des commandes sur internet
imprimer des documents ou des images nécessaires
autre – précisez ……

23. Quelles sont vos responsabilités au cabinet ?

	Je fais tous les jours (1)	Je fais souvent (2)	Je fais rarement (3)	Je ne fais jamais (4)
a. stérilisation et rangement des instruments				
b. accueil et installation des patients				
c. préparation du cabinet entre les patients				
d. assistanat du dentiste au fauteuil				
e. faire des radiographies				
f. traitement des radiographies (développer la radiographie, l'introduire dans l'ordinateur, etc.)				
g. gestion des clients et de leurs dossiers				
h. comptabilité (factures, rapports pour l'assurance, fiches de paye, etc)				
i. commandes de matériel pour le cabinet				
j. imprimer des radiographies/photos				
k. prendre des rdv				
l. envoyer des échantillons au technicien dentaire ou pour des analyses				

Autres responsabilités que vous avez au cabinet ……

24. A quel point maitrisez vous aujourd'hui ces activités ?

	Je maitrise parfaitement (1)	Je maitrise bien (2)	Je ne maitrise pas encore suffisamment bien (3)	Je ne maitrise pas du tout (4)
a. stérilisation et rangement des instruments				
b. accueil et installation des patients				
c. préparation du cabinet entre les patients				
d. assistanat du dentiste au fauteuil				
e. faire des radiographies				
f. traitement des radiographies (développer				

la radiographie, l'introduire dans l'ordinateur, etc.)				
g. gestion des clients et de leurs dossiers				
h. comptabilité (factures, rapports pour l'assurance, fiches de paye, etc.)				
i. commandes de matériel pour le cabinet				
j. imprimer des radiographies/photos				
k. prendre des rdv				
l. envoyer des échantillons au technicien dentaire ou pour des analyses				

25. Qui est-ce qui vous accompagne au cabinet (qui vous apprend, vous dit ce qu'il faut faire, vous répond aux questions) ?

	M'aide beaucoup	M'aide parfois	M'aide rarement	Ne m'aide jamais
Le dentiste	O	O	O	O
La diplômée	O	O	O	O
Les autres apprenties	O	O	O	O

26. Est-ce que vous connaissez le journal de travail (un cahier où vous êtes supposée noter ce que vous apprenez au cabinet) ?

oui
non

27. Est-ce que vous avez déjà tenu le journal de travail?

jamais
juste en première année
je ne l'ai pas tenu en première année mais je le tiens maintenant
je l'ai tenu en première année et je continue à le tenir

28. Si vous avez déjà tenu le journal de travail, vous l'avez fait parce que :

on vous a dit à l'école de le tenir
la diplômée vous a conseillé/demandé de le tenir
le dentiste vous a conseillée/demandé de le tenir
autre – expliquez brièvement ……

29. Est-ce que vous pensez que la diplômée est au courant du fait que vous êtes supposée tenir le journal de travail ?

oui
non
je ne sais pas

30. Est-ce que vous pensez que le dentiste est au courant du fait que vous êtes supposée tenir le journal de travail ?

oui
non
je ne sais pas

31. Aimeriez-vous utiliser des ordinateurs à l'école, pour vos autres cours à part celui de bureautique ?

oui
non