Augmented notebooks for pervasive learning in medical practice

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Abstract

Medical e-learning can benefit from the new technologies, and pervasive learning resources and tools worth to be introduced in the medical context. Micro-learning seems to be an interesting way for pervasive learning. But it is still difficult to propose pedagogical resources that are built by learners, from meaningful experiments. We conducted an analysis of the exchanges performed by Health care professionals in the hospital in order to understand where and when educational exchanges appear. We analyzed the type of documents exchanged. The residents' paper notebooks caught our attention first because it answers some clinician-needs and second because the computerization of such a notebook could add a collaborative dimension to the pedagogical resources. We propose a model of an augmented resident's notebook and we briefly describe an implementation using Content Management System and WIKI, before setting the discussion and the conclusion sections.

Keywords:

Medical Informatics, Pervasive learning, Health, Education.

Introduction

Aim of the work

Because of the diversity of situations of care, and since numerous learning resources exist in the field of medicine, we are interested in digital educational materials that health professionals are able to use in their care activities and that could offer contextualized knowledge. We wanted to know more about the pedagogical exchanges during care activity. We have analyzed where and when health care professionals use documents in learning situation. We identified the learning activities; and then how people do communicate to teach or to learn. When analyzing the documents used by the residents, we found the ones which have educational purpose, A paper notebook retains out attention because it is often used to gather useful pieces of knowledge and expertise during care activity.

Currently, everyone can easily use embedded technology through smart devices such as PDA, microPC, SmartPhone, an so on. We can thus consider electronic assistants for mobile learning. The second step of our work was then to propose a computerization of the notebook.

These researches take place in a national research program ANR-TELECOM-p LearNet[1]. It focuses on the design and the prototyping of new infrastructure for pervasive learning which is studying how the new technology (TEL: Technology Enhanced Learning) can support learning. "P-LearNet is particularly focused on the integration of technology, on providing easy use interfaces, on the possibility of contextualisation and adaptation to users, on the individual and collective training for formal and informal teaching, in relationship with the work and with the systemic and the training organizations". (our translation) [1].

Rational

Mobile tools are still rarely used in everyday health care practice. Their introduction still raises a number of basic problems e.g. size, battery life, not enough user-friendly interfaces. But thanks to the introduction of such devices, the health care professionals can avoid to switch from the place where he/she provides care to the place where he/she may consult informative resources. Moreover, ubiquitous environment could provide relevant information according to the context of use. In order to improve the dissemination of such devices, these tools must be therefore integrated into the activity. The quality and the accessibility of digital information, its nature, its structure, its granularity and its objectives are essential especially in the health care environment which is often stressful and urgent.

Scientific studies on the integration of mobile tools in the medical community are encouraging. Recent researches focus on the introduction of mobile tools such as PDA (Personal Digital Assistant) in the medical world. There is thus a quite abundant literature in this area with, for example, more than 200 articles from the raw research "Healthcare PDA" on Pubmed[2]. In a recent review [2] 48 articles describing the use of PDAs in the medical world were selected and analyzed. The results of this medical study are quite encouraging: access to databases seems to satisfy the users of such tools; access to drug information seems to be very popular as well. Another review covering articles from 1993 to 2004 proposed by Kho et al [3]

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[1] http://p-learnet.univ-lille1.fr
[2] http://www.ncbi.nlm.nih.gov/pubmed/

stress the interest of practitioners for learning tools: " At the bedside, they[the PDA] can be used for clinical education by facilitating calculation of clinical prediction rules, checking for drug interactions, and consulting references to expand differential diagnoses. Handheld computers are also becoming an important part of patient care and documentation through electronic order entry and patient tracking applications".

The health educational materials are often traditional teachings resources such as slides or PDF documents, re-organized to be easily accessible on the Internet. Major projects are aiming at integrating and/or facilitating access to such electronic courses. For example, the UMVF[3] (Francophone Virtual Medical University), or the IVIMEDS[4] (International Virtual Medical School) are internet portals that gather respectively French and English educational resources. Moreover, new teaching materials are developed [4]. The design of new e-learning tools uses teaching engineering methods, organizes educational contents and takes into account interactions between learners and tutors. Most courses are however designed to be read and consulted over a period which is dedicated for learning, rather than during care activity. The learning resources consulted by the health professionals during their activity must be accurate and concise, so that information is fast and efficiently reached. Pervasive learning as defined by Thomas [5]:« Pervasive learning is a social process that connects learners to communities of devices, people, and situations so that learners can construct relevant and meaningful learning experiences that they author themselves in locations and at times they find meaningful and relevant » or micro-learning as reported in the conclusion of a 2008 conference pp121[5] "A new digital micromedia ecology, and with it new learning strategies, are emerging. The shift to fragmented digital communication and information flows affects all aspects of daily work and daily lifelong learning. This calls for innovative experiences, processes and technologies: ubiquitous, personal and dynamic, casual and volatile, but still complex and effective" worth to be carefully studied.

Materials and Methods

In general

Basic computers such as desktop PCs and mobile devices such as laptop or smart phone allow a dematerialization of information as well as a high availability of information. Different users can share some information and even collaborate to build collectively some information.

Identifying the needs for technological innovations is a difficult task. Indeed, it is very tough to project user's current activity in a technical future that in addition to being unknown could partly change their way of thinking and their way of acting. It is particularly true for pervasive devices which are taking into account the application settings. Therefore it is necessary to analyze the technical possibilities allowed by new technologies and to take into account the specificities of the user's activities. The comparison of these two aspects leads to the development of scenarios of future activity. We first decided to analyze where, when and what kind of pedagogical exchanges happen during the care. Then we focused on the identification of some learning materials whose computerization could help the caregivers.

Identification of the pedagogical exchanges

The objective was to identify the information exchanged between the caregivers in the department. We chose to observe the activity of the residents. This observation was conducted in the department of Gastroenterology at the University Hospital of Lille, where three half-days of observations were made. The following items were measured: - where were located the caregivers during pedagogical exchanges; what was the nature of the information provided; from whom or where did they obtain the learning information. An observation grid was elaborated, then implemented and completed in the software Studiocode ®.

Observers have characterized real-time information exchanged between the residents and the other people in the service. Residents spent over 51% of time in the corridor or in the patient bedroom. Residents communicate most information orally. An important part of it concerns encyclopedic knowledge and procedural knowledge. Most of the information that they received comes from the seniors and few from the other residents. They provide some information to the patients, but also to the nurses and other interns.

We inquired about the residents' needs concerning the improvement of their researches of information. They told us they have no special needs. When they haven't got the knowledge to provide the care, if the latter is beyond the scope of their specialty, they make a request to a specialist. If the knowledge is linked to their specialty, they would ask a senior, or quietly make a research on a desk computer when they have time. However, this lack of needs is also due to the difficulty they have to build a vision of the future management information (very different from the current mode). We noticed that almost all of them have a paper notebook on which they noted all information that they judge useful for their activity.

Identification of educational materials and analysis of the residents' notebooks

We made a second analysis to identify the learning materials used. In particular, we wanted to know more about the information contained in the notebook, as if it was identified as very important by the residents. The activity analysis was performed with the residents of the pediatric surgery department of Lille University Hospital. Four analysis methods were used:

> *Interviews* which help to clarify about the nature of the residents's activity
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> *Observations*: ethnographic observations were conducted in the department of pediatric surgery.
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> *Questionnaire*: Following the initial interviews and observations, a questionnaire was done, asking about their habits and dealing with the communication tools they

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[3] www.umvf.prd.fr
[4] www.ivimeds.org

used and the research information they performed. It was sent to the residents of all the departments of the hospital, in order to generalize the study. One hundred questionnaires were distributed; thirty-two were completed and returned.

Trace analysis: in addition to observation and interviews, the paper documents used by interns were analyzed. Thus, three books from three residents in anesthesia were photocopied and analyzed. By studying these traces we can identify the type of information that the caregivers are using while carrying out their tasks and we can identify the operative vocabulary they are using.

The main results of this analyze are then the following:

In order to search information, the residents have access to a computer in the medicine room or in the office. In these places the desktop computers are connected both to the information system of the hospital and to the Internet. A printer is usually also available. In these rooms, they work on the patient records and they perform their Internet researches. These researches are mainly focused on medical protocols or guidelines, on the pharmaceutical properties of drugs, on the prescription and the analysis of biological data and the detailed descriptions of diseases.

The anesthesiologists have access to a computer in the operating room. Some of them have pocket pc or smart phones.

Most of the residents also have a paper notebook. This document, pretty small, is placed in the pocket of the coat. In this notebook, they note important information for their medical practice. This document has the advantage of being accessible at any time and easily usable. In our observations, they rarely used it. However, all of them wanted to keep it with them, in case to retrieve the information it contains, if necessary.

The analysis of the residents' paper notebook.

The notebook is used to memorize some specific know-how. During actual situations of work, when a resident notices useful information, he/she uses the notebook to keep it accessible. For example, a group of new residents is in a given service where a patient suffers from a specific disease. A senior doctor explains them what to do in this situation and each resident notes his/her remarks in his/her own notebook.

Most of time, the notes are not written during the care, but they are carefully reported in the notebook after the event. Information can be duplicated in the notebook, as a same subject can be treated with different approaches or can be encountered in different contexts. Colors are used to highlight some information, but the choice of the colors that are used just depends on the color available when writing notes, it has not a specific meaning. According to the owner, the book may or not be organized in alphabetical order.
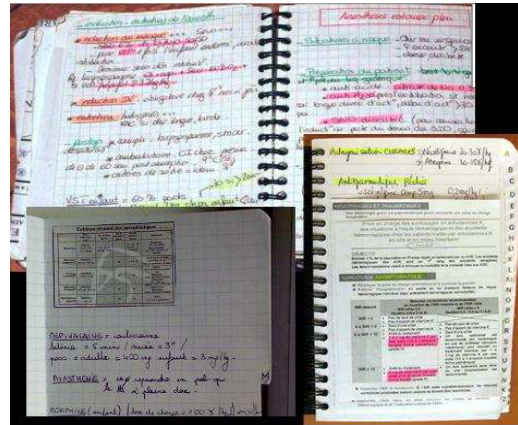

Figure 1- Examples of residents' notebooks.

Various kinds of information are included in the document: written notes but also excerpts from courses, manuals, dictionaries as well as pieces of printed paper. This notebook do not intend to be encyclopedic, it is rather a collection of "recipes" depending on services and situations. These notes will progressively create an accurate knowledge composed of useful information in a precise context of activity. Such a document is personal, dynamic and mobile; it should help to find information quickly.

Towards an augmented note book

Interest of the augmented notebook for pervasive learning

According to the specificities listed below, we have made the hypothesis that a pervasive notebook should be integrated in the activity of the residents:

At the beginning of his/her internship, the caregiver starts with an empty notebook. It is filled progressively, by the reports of important know-how learned during the activity. Obviously, this reporting takes place in the learning process since it helps to memorize the information. However, residents also copy some information manually or photocopy documents and paste them in the notebook. This process is long and bothersome. Moreover, copying is a source of significant errors. The notebook is interesting because it is made of small pieces of learning information, highly contextualized, partially indexed, annotated (color system, keywords, and titles), used during activity and used in a mobile way. The written notebook is rarely consulted but it is very important for users. When used, the consultation is brief and must immediately provide or reinforce knowledge essential for the activity. These specificities are different from usual characteristics of more traditional courses. These kinds of micro items of knowledge, very contextualized, are consulted and integrated during the care activity. It seems that to propose micro-teaching and pervasive learning activities during care, we could benefit from this experience.

Thus, we decided to experiment an augmented notebook.

The qualities of the written notebook should be preserved when computerized. *Mobility*: access to electronic notebook must be immediate and at the bedside, we will therefore emphasize mobile tools (PDA, Smartphone, NetPC, ...). *Conviviality*: the interface must be easy to understand and must lead quickly to relevant information. *Contextualization of information*: the purpose of the notebook is not to build a copy of well-known and exhaustive sources of information (as, for instance, the Vidal[5] which is one of the well known references for drug information in France) but to focus on knowledge that is relevant in a given context (as, for instance, the description of the drugs used for a child over 2 years, for disease D in the pediatric service of Professor P.). Information in the notebook makes sense only if contextualized.

An augmented notebook will enable new features.

Backup and exchange: data could be saved, transferred, with the ability to transfer its information to another media. *Efficient search*: as for example full text research or research by keyword or by category. *Relationships between concepts*: Internal links in the notebook can be proposed to connect different items of knowledge (as for instance all the items relative to acute pain). External links are also very interesting to complete the information provided in the notebook by encyclopedic knowledge, (as for instance, Vidal entries for drug information or UMVF portal for medical courses). *Multi modality*: the electronic document can easily integrate pictures, hyperlinks, sounds, videos, to the notes. It can also be consulted through different devices such as smart phone or computer terminals in the hospital. *Index and Annotation*: meta description of information can be used through tags, annotations or indexes. *Contextualization*: each note can be marked with some context : who, which country, which hospital, which services could be some of the interesting contexts to take into account. *Sharing of knowledge:* the notebook can be shared with other people once written in electronic form. *Cooperative process*: the book can be built by the capitalization of knowledge. Once collected, the information can be used by the other residents, and the information could be enriched by collaborative co-construction of the knowledge. When a new resident arrives in a service of the hospital, he could benefit of a specific know-how, which fits the habits of the service. Augmented notebook should help to share and synchronize the knowledge.

A model for the augmented notebook

We model the book as follows: a memo is the basic unit of information. This memo has a title, as encountered in the written notes. Each memo can have meta-descriptions. Each memo can be linked with other memos. A general Content Management Framework is proposed to connect the memos to external knowledge.

To perform the meta-description of the memos, in a first approach, we have retained the following axes to categorize the

knowledge: (i) Geographical location, as most of the specificities comes from the hospital or the service in which the care is performed, (ii) Medicines, (iii) Syndromes, (iv) Diseases, these 3 axes covering the main entries to describe the content of the memo, and (v) Guidelines and protocols. These descriptions help to provide contextualized information. Of course, these axes could change if necessary.

The main features of the augmented notebook come from the analyses and deal with: remote access; import and export of data, collaborative authoring tool, relation to external resources; indexing of the information entered through semantic annotations or through contextual elements from the practice (as the author of the memo or the name of the service in which this resource is meaningful).

Architecture

The architecture developed for testing is based on three components: a server that hosts the memos, an experimental network infrastructure, and mobile learning devices. The server is accessible both from the internal network of the hospital as the Internet, so that residents can learn or improve the memos even when duty off. The experimental network infrastructure consists of a set of wireless terminals located in clinical departments. Only devices provided for the experiment can be accessed. The devices consist of SmartPad (nokia N90) and netbook (eeepc Asus 901).

Implementation

Different kinds of collaborative tools were examined in order to implement this augmented notebook: CMS (Content Management System), Wiki, social networks, blogs. Social networks (e.g. Facebook[6]) are originally designed to improve the social links between individuals, but they can now be implemented in a private sphere (e.g., Ning[7]) and offer many tools to share files or other kind of information, such as forums or "walls" of information. We didn't choose them as to perform a pervasive notebook we needed to structure our data. Blogs, highly structured chronologically were not retained as well.

CMS tools are designed to administrate and manage the online pages. They are effective to publish pages, to facilitate the design of the pages by using templates and to control the different validation steps before the publication of contents. A CMS, however, is not so suited to contextualize the information presented in the memos. We chose CMS to implement the general framework which gives access not only to the residents' notebook but also to external information, pertinent for the caregivers (publication databases, directory, dictionary of drugs, etc..). We used Joomla[8], which is an open source software that provides sufficient features.

Wiki tools effectively facilitate the collaborative construction of information. A wiki can easily build a network of linked

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[5] http://www.vidal.fr/

[6] http://www.facebook.com
[7] http://www.ning.com
[8] http://www.joomla.fr

pages. Interesting mechanisms are implemented such as the creation and modification history that helps to control the information. It is possible to organize discussions around the concepts proposed in the pages; it is particularly interesting to secure the validity of the information provided in a collaborative way. We therefore propose to hold the notebook via a Wiki. There are many wiki engines available in open source. The MediaWiki[9] engine is used for the free online encyclopedia Wikipedia, it has proved to be robust. Its features meet fairly well our needs. Each resident's memo can then be viewed as a Wiki page, the title of the memo playing the role of the hyperlink. A discussion area on the pages is easy to implement. The concepts presented in the page may refer to internal or external links. This Wiki has additional features provided by an active community of developers. Among these features, the interface with LDAP for authentication, the possibility of exporting pages to PDF, the advanced text editor are of particular importance for our project. Structuring documents per category is proposed. Each category can be seen as a set of tags associated to that page. The Semantic MediaWiki[10] extension can annotate items or typed relations (links) between items. This Wiki has been chosen for the implementation of our prototype.

Results

Through the analyses of the pedagogical exchanges performed during the care activity, we identified a specific document: the notebook mainly used by residents. The computerization of this notebook opens up interesting prospects for pervasive learning. We have developed the infrastructure necessary to deploy a test in services. Firstly, we distributed mobile tools: Asus eeePC 900 or 901and Smartphone Nokia N90 to some of the residents working on the service in which we conduct our experiments. These tools didn't integrate the augmented notebook. The use of mobile tools was then very low, despite the number of encyclopedic knowledge available online. It confirms our hypothesis about the importance of the services offered. Then, we have developed a prototype of augmented notebook which provides contextual information according to the main axes of categorization identified. Next step of this work is the evaluation of the prototype. In particular, the collaborative aspects for the capitalization of knowledge will be explored.

Discussion

Many research opportunities are opened by this exploratory study. The capitalization of knowledge should help to identify general knowledge, or specific knowledge. Learners should become actors to build learning materials. It could reveal knowledge linked to teams (in such service, this drug is often used with the dosage xx/l) or to individuals. In particular, some habits could become explicit and such knowledge could save precious time when new people arrive and don't know yet the implicit rules. We must explore the duality between the collaborative notebook and the personal notebook, combining the contributions of a wiki tools very efficient to share and co-build information, with fair tools allowing to tag personals data.

Conclusion

The acquisition or the consolidation of knowledge can be based on other activities than the consultation of encyclopedic information; therefore residents store know-how information and examples on notebooks or USB storage. Improving e-learning through pedagogical engineering is obviously important, but there is still a room for new modalities for learning: modest, punctual but precise, which could provide small and contextualized documents. Our analysis of the learning resources that are used and exchanged during the care, highlights the difficulties that we face with in integrating learning in everyday practice. This work just sketches solutions but it provides a model of document able to capitalize applied learning knowledge. It might help us to introduce new digital material in a pervasive learning perspective.

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