

QUALITY, USABILITY AND ECONOMICAL ASPECTS IN A MEDICAL WEB-BASED TRAINING SERVICE

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Abstract

The paper describes activities and results achieved on quality, usability and economical aspects by the project named EETAH-on-line (European Education, Training and Accreditation in Hematology on-line). The goal is to improve and harmonize professional skills and competences in this medical field. The target users are: students, physicians, nurses and technical staff involved in the hematological education and training; expert hematologists who need continuing training; all physicians of linked specialties who may take advantage of these scientific contents; institutions running certified programs in the hematological education, training and accreditation.

Key words

Medical training, hematology, web-based platform, certification, evaluation, harmonization.

1. Introduction

EETAH-on-line is a two year pilot project (partially supported by the European Commission under the “Leonardo da Vinci” Community Vocational Training Programme - EUR/02/C/F/PP-84703, Directorate-General for Education and Culture) to develop and evaluate an accredited on-line trans-European platform to improve, and harmonize skills and competencies in the field of hematology. The project started in 2002 and is based on a cooperation between various medical and ICT partners involved in tele-medicine and tele-education. Partners of this joint research team are: the European Hematology Association (EHA), project promoter, the European School of Hematology (ESH), the University La Sapienza of Rome (Department of Cellular Biotechnologies and Hematology), scientific coordinator, the Italian Catholic University of Sacred Heart (Research Center for the Development of Automated Methods in Hematology), the University of Barcelona (Institute of Hematology and Oncology), Nergal S.r.l, and the Luiss “Guido Carli” University (CeRSI - Research Center on

Information Systems). The first year results of this project have been described in a previous paper [2].



Objectives and Results Achieved

With respect to the initial project aimed at developing by the end of the time frame a quality certified prototype, capable of supporting on line education, training and accreditation of professional competences in the field of haematology, we have decided to change the final achievement.

After the development of the prototype, available on-line using a password, we have tested it in many diversified manners:

- the universities involved as partners have used the tool with students and trainees involved in the hematological field;
- we have collected comments, criticisms and feedback from all the scientific partners involved and we have discussed together all the aspects in a plenary project meeting;
- during the EHA (European Haematology Association) annual congress, held in Lyon last year, at the EHA booth it is organized a PC station internet connected to the prototype: all the interested people were able to enter into the web site containing at that time a detailed refined template and some clinical cases. After navigation, people were asked to fill in a

questionnaire aimed at evaluating the technical aspects, the format and the web site usefulness. Moreover, they could write comments and availability in scientific contents submission. We have evaluated more of 50 not anonymous fully checked questionnaires.

After this testing phase, that gathered mostly positive comments, and after some suggested changes, all partners decided to make an effort to anticipate the public launch in concomitance with the most crowded hematological congress, ASH. We did it: the web site has been made publicly available at ASH at both the EHA and ESH booths.

From the beginning of the availability on line of the prototype up to December 18 2003, we have registered more than 1500 connections for an evaluated number of 856 single visitors.

Due to the decision to anticipate the public launch, the scientific committee has produced 14 clinical cases that have been submitted to external reviewers. The reviewers' comments have been forwarded to the authors for the required changes and following approval by Prof. E. Montserrat, chairman of the Scientific Committee, cases have been publicly uploaded. So far, 8 of the 14 submitted cases have correctly gone through all these phases and are indeed freely available on line.

For the same reason (early start of the public launch), the test and the validation Workpackage (WP4) was started three months ahead of schedule in order to have the site properly tested and validated before the public launch.

Medical Education and Training

In Europe healthcare operators are required to demonstrate participation in continuing medical education (CME) programs following qualification. Traditionally these courses are conducted face-to-face or via reading materials. With the development of web technology, the capability for such courses to be completed on-line has become apparent. This enables healthcare operators to access information at any time and from any location and allows the potential scope of available information to be greatly increased. Traditional web systems are too simple to be really effective. Complex commercial e-learning systems require a complex configuration and are too "technical" for customers [1]. Furthermore the focus of these systems is often on the on-line interactivity, while a structured arrangement of educational content must be the first goal. The platform has the following features:

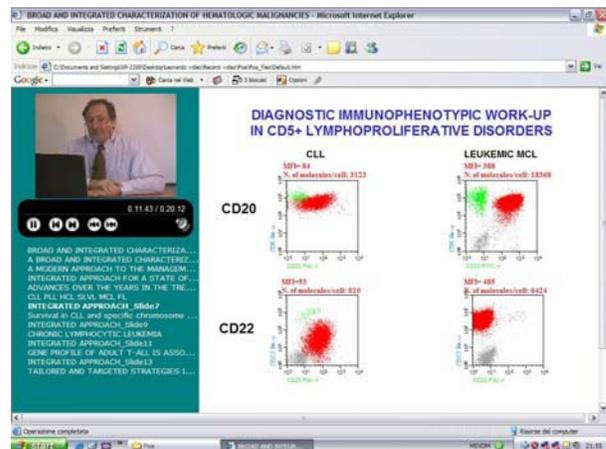
- *structured lessons.* They are stored in a database maintained by an administration tool. Every course contains evaluation forms. Courses structure (lessons, concepts) is readily editable and the result available;

- *innovation in content.* The system is based on multimedia objects with images, videos, powerpoint slides and texts;
- *on-line interactivity.* Learners have access to teachers using multicast audio/video/whiteboard interaction in multi-user sessions (virtual classrooms). The quality of audio/video depends on the network but multicast allows exploitation of asymmetrical ADSL or a satellite network;
- *minimum configuration of the clients.* The system is developed in Java and use Flash animations. So it runs on most operating systems and needs no configuration of the user workstation. Also on the server all open software products are used to reduce system cost and increase performances [3].

The system is based on a central server containing all content and structure of content. The software facilitates access to structured information stored on a server representing education content. A module represents a course and is built of "lessons". The lesson is built by "concepts" and "self evaluation forms". The "concept" is the key feature. It is a software entity representing an extension of a slide. Usually a slide is what in a conventional lesson the teacher draws on the blackboard to present an argument. The "concept" is a multimedia extension of this class. The "concept" can be a slide (HTML or a raster image), a fragment of audio, a fragment of video or a mix of all these at the same time, presented together on the screen [4].

Submission of New Clinical Cases

Clinical cases are collected in the local database. Every participants can log on the server and consult them also with multimedia effects and simulations.





The application interacts with the multimedia distribution client to start the client when new content has been received. The structure of the access authorizations of the database is modified to introduce the data-structure of the “owner” of the patient. In this way operations on data of a patient belonging to a different Institution must be explicitly authorized. A sophisticated encryption system is introduced for data in transit on the network.

After a positive feedback, authors can send their material organized according to the template presently available in the website. Each clinical case must have a title, authors and affiliations. It should be organized according to a preliminary index (on the left of the screen) and the authors have the opportunity to organize the case along a time axis in different phases (diagnosis, follow-up,). Each item of the index needs to be linked to a content, e.g. text, data, images, etc., associated with a further description.

For each image, we need a detailed description of the content, as well as of the technical aspects (i.e. staining and magnification for microscope images, cut-off level for CT scans, projection for X-rays, etc.....).

In the diagnostic pathway of each case, we need at least one or two tutored interpretative comments: differential diagnosis with detailed comments on wrong answers, as well as on the correct one that will be displayed as pop-up comments.

For each clinical case, we need a final diagnosis and, when possible, comments on differential diagnosis.

In the text related to each clinical case, the author is required to select specific terms (the number is open) to include into the glossary of the web site with a description.

For each clinical case, the author has to release a copyright agreement.

Training Tools, Functionalities and Additional Benefits

In addition to the benefits listed in the previous section, the new style of digital media-based learning also offers other, less obvious advantages:

Flexibility and Accessibility. Students in the field of hematology can access learning content at any time from any location. Digital media allows them to take charge of their own training by accessing a library of video-on-demand content. E-learning offers learners a risk-free setting, enabling them to make mistakes and experiment with new ideas without risk, and allowing for reflection and review [6]. Interactive simulations make learning more interesting and engaging, resulting in increased retention.

Adaptability for Complex Topics. Training on medical cases, is an area traditionally left to small-group, hands-on classroom training. In the past, these areas needed expert instructors and special training facilities. These topics are challenging because students find it difficult to visualize complex concepts when they are just presented verbally or in writing. Simply porting an existing course to an online environment can often make the situation worse because students cannot clarify their understanding with the instructor. However, careful use of multimedia or digital media can improve the learning process. By introducing audio and video-enabled digital media content, students can process complex information more effectively.

Performance-Based Training. Performance-based training involves assessing the effectiveness of individuals and organizational structures, diagnosing the causes of performance problems, and recommending interventions to improve the situation. Using digital media technologies to diagnose organizational and experience problems, present solutions, and measure results can have an immediate effect on organizational performance. Data is easier and cheaper to collect with focus physician groups and interactive surveys conducted online. Training can be more easily focused on problem areas.

Content Creation There are four primary infrastructure requirements that we used for creating medical content:

- Capture and encode. Capture is the process of converting an audio or video input into a compressed digital format, such as Windows Media Video 9 (WMV). The digital format is archived as a file, fed directly to an encoder, or both. Encoding is the process used to digitize audio and video input into a compressed format at the desired bit rate and quality. This is typically one seamless process in which a digital input from a camera, tape, file, or other digital source is encoded into WMV that can be archived, streamed, or both.

- Storage. We used two scalable and reliable networked server.

Authoring tools. One value of digital media comes from the integration and synchronization of multiple digital media formats to make compelling rich-media

presentations. We adopt various rich-media authoring tools to simplify the content creation process and allow different functionalities with a graphical user interface. Two examples are Producer for PowerPoint 2003 and Windows Movie Maker.

Development tools. Development tools, typically in the form of SDKs are intended for developers to program custom solutions. There are situations where it will be desired to create more sophisticated content for special events, such as integration of Macromedia Flash or dynamic HTML (DHTML) into a presentation. The use of existing authoring programs may be preferred if content creation is an ongoing business process because using development resources to create digital media presentations can be costly and time consuming.

Content Distribution and Management

Once a segment of digital media content is produced, it needs to be distributed to the intended audience in a timely and cost effective manner. Enterprises will want to manage this distribution process to ensure optimal use of storage and network bandwidth, while ensuring that the content is secure and highly available. The majority of the infrastructure work for distribution and management falls into three areas:

- **Replication.** As content is produced and made available to end users, a large amount of hard disk storage is required. Although storage solutions can be implemented in a variety of ways, a common implementation is to use one central repository and many smaller cache servers on the edge. Content can be proactively scheduled for distribution to specific locations within the enterprise, ensuring availability and improving viewing quality while minimizing WAN expense.
- **Redirection.** As viewers request content, the cache/proxy server redirects the content request to the preferred server when appropriate.
- **Digital Media tools.** Windows Media technologies enable you to control the format of the content, how it is assembled, how it is streamed, how it is secured, and the options for playback. They play a vital role in determining implementation and support of an enterprise solution.

When designing a storage solution, consider the access requirements, as this will often dictate the solution with the appropriate bandwidth for retrieving stored content from hard disks. Typical options include Network-Attached Storage (Windows-based NAS), clustered Windows file servers or a Storage Area Network (SAN) based on a fiber channel storage system, and connecting multiple hosts to central storage through a 2-gigabyte (GB) fiber channel [8].

Quality and Certification

Quality in EHATOL-on-line is assured firstly by conform to the certified Health On Line (HON) criteria.

Secondly, quality of didactical materials is assured by a process of review as well as to the publication on scientific magazines.

In the realization of web-based system the goal of researchers team was not only to achieve quality in one aspect but in every sense.

Particularly, partner mainly involved in quality management (CeRSI-Luiss), worked for the identification of final users, their query, realization of video lessons.

If we talk about the quality of the educational aspect of EHATOL-on-line, the goal was achieved in the management of the process because the system let monitor and control wandering the process through a retroaction rate very high and in the interaction between users and didactical materials, users and teachers and all users [7].

Besides EHATOL-on-line is a very high quality product not only for the technology used and the interactivity but also for the punctual definition of learning objectives and processes for their reach.

EHATOL-on-line quality in the structure:

- All the staff was involved in the process of total quality management according to a way modified routinely
- Human resources are very professionally resources with an high know-how in their own field
- Technology resources are right and not oversize in comparison to the goal of platform. So there aren't problems of users alphabetization
- Clearness of organizative structure: everyone know his role and task
- Effectiveness of didactical model
- Take care of users. System simplifies administrative and bureaucracy processes

EHATOL-on-line quality in the process:

- It was monitor in real time each operation and interaction to verify mistakes
- System helps users to evaluate their selves
- Personalization, it can interact with educational materials every time you want.

EHATOL-on-line quality in the evaluation:

- Evaluation of user satisfaction through particular session (it is still in progress)
- Evaluation of know acquired through verify and certification tests
- Evaluation of know transferred in other fields: in their job, in the research

In summary, strengths point of platform that let to do it a very quality product are:

- Clearness of goals
- Clearness of module organization
- Clearness of assigned task to the users

- Assistance area (has to be realized)
- Continuing monitor system able to identify critical area in real time (it is still in progress)
- Organizational clearness: it is indicated time and way of register, services offers, administrative way, and ecc.
- Care for need of users: assistance services, speed management of problems, continuing support
- Access: very good the alphabetization level required, so it is very useful and friendless
- Costs: management costs are similar to their of other systems
- Teacher method: it is the e-learning method and it distinguishes itself for the simplicity and expositive clearness
- Interaction: work are still in progress in this sense
- Organizational aspects: it is the result of collaboration between partners. Each one has a particular competence in a scientific area
- Novelty: it satisfy the originality requirement in the ematological area
- Timely: it can bring up to date continually

For the certification of content this point is also in progress to identify the best system for the evaluation of know acquired by users, also if in the platform the session certification is already prepared [10].

In each case certification of know is realized by European Council for Accreditation in Haematology (ECAH) that is collaborating with ESH to write guidelines and European accreditation principles similar and recognized in all the country in order to accreditate wok done by EHATOL-on-line.

While for the certification of web site it is reached trough the brand HON that appear on the homepage of web site that certified conformity to the well done medical site criteria.

Usability

Usability is the effectiveness, efficiency and satisfaction with users reach specify goal in specify environment. EHATOL-on-line satisfy Jacobs Nielsen usability principles:

- Visibility of system state
- Correspondence among system and real world
- Control and liberty of use
- Consistence
- Error prevention
- Recognition more than memory

- Flexibility and efficiency
- Aesthetics and minimal planning
- Help the consumers to recognize, diagnose and overcome the situations of error
- Helping and documentation

These characteristics was goal of every phase in the realization of platform beginning the definition of contents (they worked to give users not only they need but moreover); structure definition (platform was realized according to a hierarchical structure like a tree that beginning from homepage arrive in three directions and it has the advantage to be cognitive and more simplify to guide); interface definition with an accessible design, recognizable design (users can identify in each time web site that gives an unity sense), navigable design (it is important that user can have a mental map of web site), predictable design(it is important that user can foresee results of each action) [9].

In summary system is usable for:

- *coherence*: it means that similar task have like results similar actions sequence, so users acquires experience in a session can exploit it for a successive ones;
- *compatibility with real world*: coherence refers to the similarity between functions, compatibility can face new tasks on the basis of old users know
- *signals offer to users*: in order to save usability it is necessary to not overload cognitive senses, in this way user have the possibility to use one cognitive sense each time
- *clearness and visibility*: information have to be read easily without generate confusion.
- *intuitivity*: it was designed to be utilized quickly and easily without a lot of instructions.

Economical Aspects: Realization Costs

For the realization of the platform have been supported different costs: monetary and non monetary. Between monetary costs we have:

- Costs for the realization of digital contents of web-site. Education effectiveness in e-learning projects can be achieved with high costs in comparison to traditional education projects. This cost has to be divided on the basis of educational events
- Costs for the upgrade of digital contents. This voice has been foreseen by the technical partner
- Costs for content hosting (this voice is included in the first voice)

- Costs for the purchase of Learning Management System. It is the main cost. However in this moment the LMS is not realized yet.
- Costs for the administration and management of the platform. These costs have been supported until this moment because in the future the technical features of the platform will permit to manage automatically system and clinical cases
- Cost for the dissemination (costs for meetings, etc.).

Between non monetary costs in an e-learning system we can find the following:

- Coordinate costs between different partners with different competencies. These elements generate another component of costs, transaction costs. In the case of EHATOL-on-line we had confidential and vague contractual obligations, not determined in specifically. They are specified only in connection to the general interest of platform.
- Quality costs: conform to expectation of each one, conform to pre-determined requirement. It is a research project, a type of “Work in progress”, there aren’t standard guidelines, so there are inefficient. Between quality costs we have: planning costs, assessment costs (to verify the compliance with the expected objectives), and failure costs.
- Costs for intellectual property
- Costs for time: update, adjustment, downtime.

Economical Aspects: Financial Sustainability

EHATOL-on-line is now partially sponsored by the European Commission and by Novartis but in the future we have proposed a financing plan to support the project through the payment of services. Before we have to specify:

- the economical analysis begun June 2004;
- we consider a number of 3000 users;
- we don’t consider the inflation rate for the definition of price (inflation rate isn’t consider for the costs);
- we suppose a time horizon of five years.

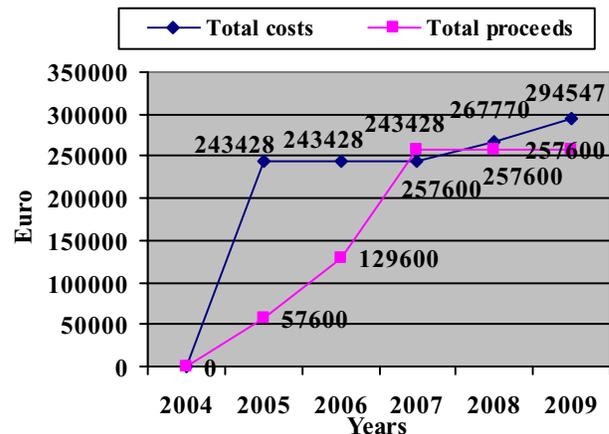
If we consider the typologies of potential users and the innovative features of product (relative advantage, simplicity, experimentability), we can suppose that the adoption rate of innovation will be positive. After a market survey we have fixed the price for users in euro for credits (we have done three hypothesis: pessimistic 8 €, wait 10 €, optimistic 12 €). Price fixed by our mayor competitor, ASH online (American Society of Hematology), is more higher than this. We have supposed that the necessary credit for each physician, according to Italian law because there isn’t an European

law yet, is 150 credits in five years (80% can be achieved on the web).

We have also supposed that physicians participate within three years, otherwise they update their self in traditional way.

	Pessimistic vision	Prudent vision	Optimistic vision
Market dimension at the end of time horizon	1000 users	1500 users	2000 users
Market share	$t_1 = 300;$ $t_2 = t_1 + x = 600;$ $t_3 = t_2 + x = 1000$	$t_1 = 500;$ $t_2 = t_1 + x = 1000;$ $t_3 = t_2 + x = 1500$	$t_1 = 650;$ $t_2 = t_1 + x = 1300;$ $t_3 = t_2 + x = 2000$
Sales price for credit	8	10	12

The following diagram illustrate break even point in the



pessimistic view.

It is possible to view that the project achieves the break even point at the third year. In conclusion we can say EHATOL-on-line will meet expenses with payment by users in the pessimistic view, while in an optimistic view the break even point will arrive more before.

Conclusions

EHATOL-on-line is now completed and full operative. It distinguishes itself for the accurate and upgraded information that come from who have the best experience and know to deal with discussed theme. The web-site is simple to use, layout is well organized, identifiable with simplicity and simple to remember).

The main characteristics of project are: reliability of published information, usability of web-site, approachability for all users.

Although the evaluation of platform is positive, interventions to improve it are still in progress. In particular there are some services to add:

- Assistance area
- Continuing monitor system that identify critical area in real time
- Forum area, news (for the upgrade of physician in their interest area), notice board (to service communication to users), helpdesk (although web-site is good and well done it is always useful to insert information for the right use of platform), faq.
- Evaluation of user satisfaction through particular session

For the technical specifications:

- Introduction of a database to an automatically organize and management of content
- Administrative police and outline of access with the possibility to limit users in particular didactical way respected some preliminary
- Introduction of a system that allow authors to insert new content in a database.

Positive are also the perspective evaluations of future sustainability of system on the basis of scenario analysis. They are only hypothetical in this moment but they will be verify in the next month with the account of users participation.

Very important in this sense is the sponsorization of EHATOL-on-line in conference, events to the direct target like it was done in June 2004 in Geneve.

EHATOL-on-line is different for high quality content, for the safety that offers to their users and for the possibility to certify the haematologists know-how.

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