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Validation of an ICT system supporting Competence-Based Education: the eSchooling case

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ABSTRACT

This paper aims to present the evaluation of eSchooling, an ICT system supporting competence-based education. The eSchooling team ran an experiment involving ten high schools throughout an entire school year, so as to cover all the teaching stages (from activities planning to the final students evaluations). In order to guarantee objectivity and independence, external experts performed monitoring, validation and evaluation of the experimental results. These experts analysed different aspects: the logs of the eSchooling system, the response of a user community, the logs of the interactive e-book system and the outputs of users focus groups. The main indication derived from the analysis of the collected data is to involve entire groups of teachers of the same class, rather than isolated ones, when evaluating such kinds of educative tools. Another suggestion is to move in the direction of a tighter integration with other ICT tools such as the electronic board for recording activity, even when it is not competence-based.

***Keywords**: Evaluation of eLearning tools - Interactive e-books evaluation - Users community analysis- Software tools for competence-based education.*

Valutazione di un sistema informatico di supporto alla didattica per competenze: il caso eSchooling

Questo articolo presenta la valutazione di eSchooling, un sistema informatico di supporto alla didattica per competenze. Il team di sviluppo di eSchooling ha condotto un esperimento coinvolgendo dieci scuole superiori durante un intero anno scolastico. Per garantire obiettività e indipendenza, sono stati coinvolti alcuni esperti esterni per eseguire il monitoraggio, la validazione e la valutazione dei risultati sperimentali. Questi esperti hanno valutato diversi aspetti: i log file del sistema eSchooling, la risposta della comunità di utenti, i log del sistema di e-book interattivo e le risposte dei partecipanti a focus groups. L'indicazione principale emersa dall'analisi dei dati raccolti è quella di coinvolgere interi gruppi di insegnanti della stessa classe, piuttosto che insegnanti isolati. Un altro suggerimento è quello di muoversi nella direzione di una maggiore integrazione con altri strumenti informatici, quali il registro elettronico, anche quando questi non sono specificatamente basati su competenze.

***Parole chiave**: Valutazione di strumenti di eLearning - Valutazione di e-books interattivi - Analisi della comunità di utenti - Strumenti software di supporto alla didattica per competenze.*

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Introduction

"Competence" is a term that is becoming more and more central in schools. According to the Oxford dictionary, competence (or competency) is "the ability to do something successfully or efficiently", while the Business Dictionary defines it as "a cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organization) to act effectively in a job or situation. Competence indicates sufficiency of knowledge and skills that enable someone to act in a wide variety of situations". In the European Qualification Framework (2008), the term "competence" is defined as "the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy".

In recent years Competence Based Education (CBE) has been strongly pushed by the EU Commission (Recc, 2006), and subsequently by the governments of most Member States. Unexpectedly, it seems that ICT solution developers did not pay much attention to this fact. While generic support to learning, both in classroom and at a distance, has spawned a whole field (e-learning) and brought to a wealth of technological solutions (both proprietary and open source), it is very difficult to find systems specifically addressing the issue of supporting CBE. That motivated the birth of the eSchooling system, a joint initiative of Telecom Italy SpA[1] (the largest telecom operator in Italy), Edizioni Centro Studi Erickson SpA[2] (an Italian publisher) and two local SMEs, Memetic Srl[3] and ForTeam Studio Srl[4]. The project is co-funded by the local government (Autonomous Province of Trento) through a Provincial Law on incentives for businesses. The project, described in detail in (Ronchetti et al., 2015), had the following goals:

- defining new models of innovative teaching, which are strongly based on the competence approach, as well as supported by digital technologies;
- investigating new learning practices, possibly enabled by digital books;
- building a software prototype that, throughout functionalities of a Learning Management System, supports the above mentioned methodology and practices.

In practice, the eSchooling prototype aims to assist teachers developing a CBE plan, running activities and assessments to implement the plan, communicate among them and with the families. Throughout these tasks, the system keeps track of the competences, organized in a standard taxonomy, even though schools could define their own competence taxonomy. The system also provides a tool to profile the students learning style, as a tool to e.g. help composing the students groups, but also to stimulate metacognitive reflection. The

[1] www.telecomitalia.it
[2] www.erickson.it
[3] www.memetic.it
[4] www.forteam.it

eSchooling prototype also includes a model for interactive e-books, inspired by the work by Hwang et al. (2014).

The global project plan included an experiment aimed at testing the system and validating the underlying model. The experiment lasted one school year, so as to cover all the stages (from planning to the final students evaluations), and involved ten high schools (mostly in the Trentino province), with an average of four to five teachers per school.

While the eSchooling team run an experiment, external experts performed monitoring, validation and evaluation of its results, so as to guarantee objectivity and independence, according to the best practices (such as e.g. those used in software testing). Different experts groups evaluated different aspects of the experiment: the logs of the eSchooling system, those of the interactive e-book system, the outputs of users focus groups and the response of a user community. The present paper reports on the results of such analysis.

Analysis of the log files

Automated logging of interaction between users and a software product is a common practice. This method consists in recording user's inputs in a way that it is not intrusive for the user, so that all the user's action can be analysed later.

Logging can be done at different levels. At the lowest level, all user's mouse movements and keystrokes are recorded; at a higher level, a record is only made of a sub-set of specific actions. The user's inputs are stored in a text file (*log file*) along with a timestamp, preferably in a structured way to make the analysis easier. Analysing the log files during the evaluation of a product allows developers understand where the system does not work properly. However, log files analysis is even more useful to study the behaviour of the user during the real usage to extract information about the effectiveness and efficacy of the used tool. For example, Lee et al. (2001) measure the effectiveness of marketing efforts by analysing the clickstreams of online stores. Cocea and Weibelzahl (2009) demonstrated that, by analysing the log files from a web-based learning environment, they are able to detect the learners' level of engagement, whereas Romero et al. (2008) associate the analysis of the students' usage data in a web-based course to the final marks for developing an effective students classifier.

The eSchooling logs are built in a way that, for every meaningful user action, the main info - comprising the action itself, a user identifier and a timestamp - are recorded by the system. The recorded actions include the logging in and out of the system, the access to the digital library to add or take an artefact, the creation of work plans, scheduling, assigning and evaluating activities. References to competences are traced throughout the various activities.

The log files of eSchooling have been stored day by day, from November 2014 (when the first eSchooling prototype was released and the experimental study in the schools started) to June 2015 (when the teachers activities ended). The collected files have been analysed at

two levels: first, at a low level, only measuring the activity each user globally performed with the system, and second, extracting the information regarding each user and looking at his/her specific actions when using the systems. Given the different number of teachers per school participating to the study, the data related to each school have been normalized by computing the average.

From the analysis, it emerged that out of the 46 teachers for whom an account was created, 37 actually used the system. 20 of them were teaching human subjects and 17 teaching scientific subjects. They belonged to 10 different schools.

By simply analysing the size of the log files (which is proportional to the activity performed), we can see how the system has been used over time.

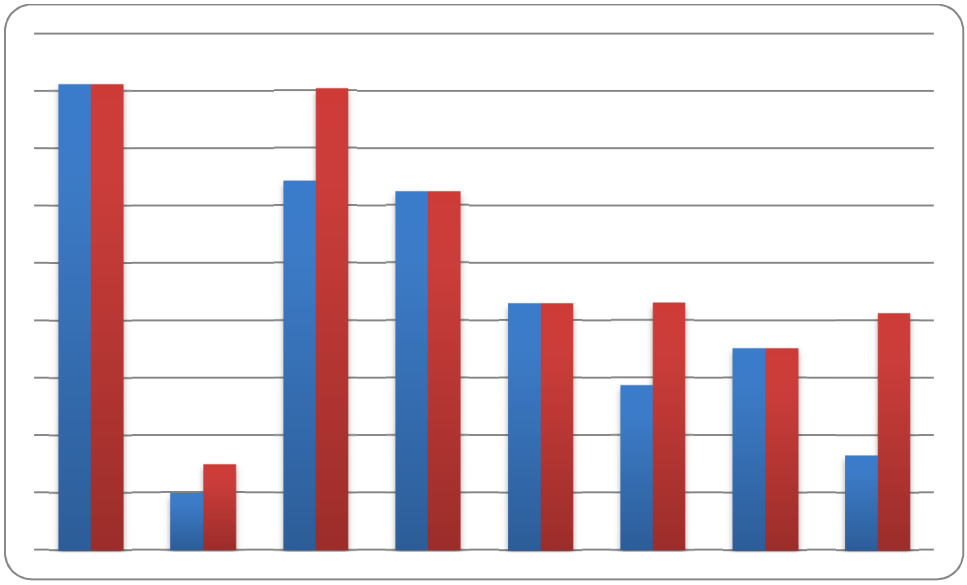

Figure 1 - The size of the log files per month. In blue the raw data, in red the normalized ones.

Figure 1 depicts the distribution of the log files' size (i.e. the number of lines), from November 2014 to June 2015. Raw data are the blue columns. At first sight, these data show a monotonically decreasing use of eSchooling in the considered period, with a peak in November, when the first prototype of the system was presented to the schools. December shows an anomaly, and then the usage is constantly decreasing, with a small surge in May.

If one instead considers the actual *density of usage*, taking into account the actual school days, the data show a slightly different story.

The applied correction factors are 3/2 for December and 5/4 for January (taking into account the impact of Christmas and New Year's vacations, respectively 10 and 6 days), 3/2 for April (due to Easter vacation, 10 days), and 5/2 for June (as schools ended on June 12). No correction is applied for the other months, having a regular school calendar. The

normalized values are plotted in the red columns. The normalized activity data still show an evident decrease after the initial period, but it reaches a more or less constant plateau during the second school semester (February-June).

One also has to consider that, unlike what was planned at the beginning of the project, the system was not completed on experiment's day one: at the beginning only the feature for the didactic activity plan was available. The other feature followed later, starting from January and continuing throughout the experiment lifetime, with releases that included new features and bug fixes. This explains the "December dip", as after having planned the activities at the beginning, there was not much more that one could do. Furthermore, the initial peaks are probably due to the initial curiosity, and the decrease can be explained saying that some of the teachers "dropped off" the project due either to loss of interest or to the pressure of other duties.

Disaggregating data over the schools also offers some insight. Some schools were very active and regularly used eSchooling over time, while others used it only during limited periods and/or have been less active.

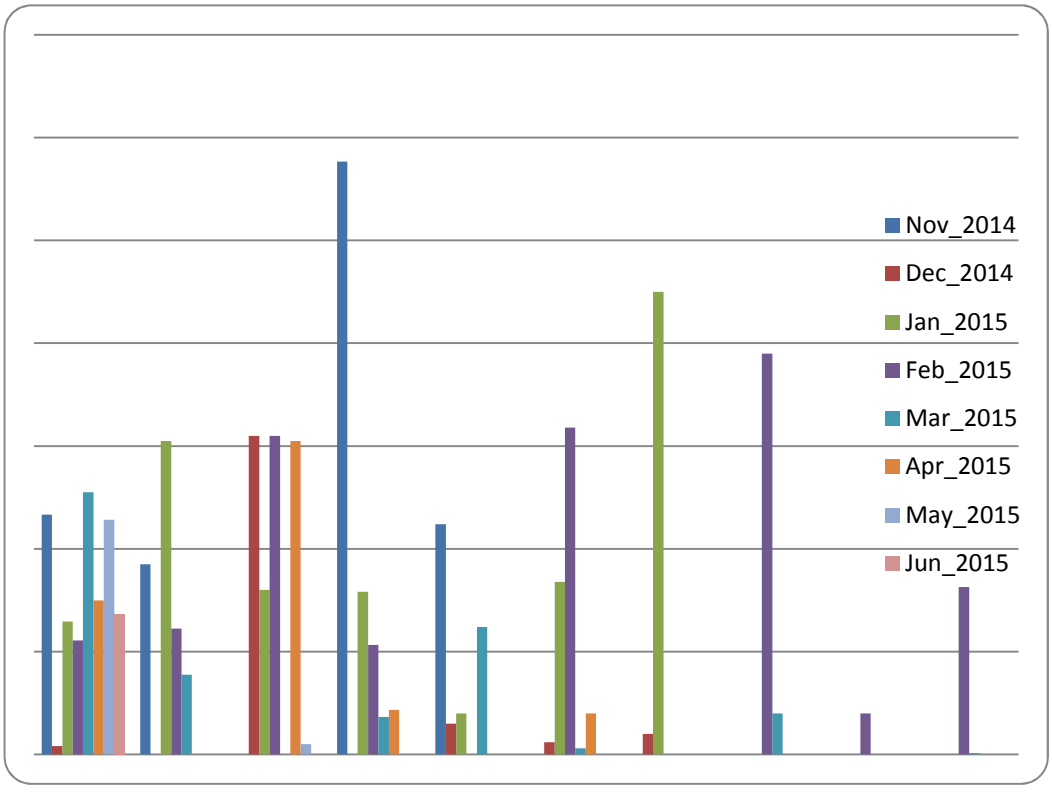

Figure 2 - Temporal sequence of system usage by school

Figure 2 shows the temporal access series for each of the ten participating schools. Some of the schools show a usage, which is essentially negligible, except for a particular month (either January or February). In practice, they were active only when people from the eSchooling team personally met the teachers for training. Other schools (the ones on the left hand side in the above graph) show instead a more regular usage.

The same usage heterogeneity can be seen when investigating the behaviour of individual teachers. Out of the 46 teachers involved in the experiment, 8 did not even log into the system once (17%). Only 17 participants (36%) were reasonably active and used the various features of the system. The rest of them (47%) showed a marginal involvement.

Community analysis

The experiment had also foreseen the teacher support via an on-line community. Google Plus was chosen as a tool. The choice was motivated by the fact that the Google Apps environment was already integrated into eSchooling, and some of the teachers already had experience with such suite. Moreover, Google Plus allows tagging the messages for classifying them, and permits to create a reference section where we could keep as number of siding tools, such as links and explanations. Finally, it is perceived by the teachers as "more professional" than Facebook.

We know that an online community does not start magically out of nothing, and that there is a critical mass problem (Raban et al., 2010). To add value to the community, we used it to keep on line a calendar of the project activity, manuals and video tutorials (posted on YouTube account of the eSchooling community). Inside the community the integrated use of other tools such as Google Drive (for the storage of the community documents) or Google Modules (to collect data and information from members) was aimed to train teachers in using in an integrated manner a number of different tools. We also invited all participants to a face to face event: an half a day seminar was organized on the theme "Competences in practice" where some teachers were invited to present their experience in CBE. The event was followed by a mini-party, with the explicit intention of creating an opportunity for establishing some relations, which transcended the virtual world. Stimulation was regularly provided throughout the experiment lifetime. Sixty members were invited: it is essentially the same group of teachers who were involved in the experiment. Out of the 47 who actually enrolled, 10 users were proactive (21%). Three users gave substantial contributions, by providing good practices indications on three different areas (plans, activities, e-books).

At the end, a questionnaire was run to get quantitative data and understand the reasons of the limited active participation. Twenty-one participants responded to the questionnaire (45%). Only 10% of the respondents considered the community to be of little value to keep up to date with the project, to get deeper insights in the projects themes and to share good practices. On the other hand, 90% of the respondents declared that the main hurdle they encountered was the lack of time. Only 14% declared to have no interest in continuing to use the community in future, in the project follow-up.

Interactive e-book feedback

The eSchooling prototype also included an on-line interactive e-book reader: an application that allows users to a) read an e-book in the browser, b) annotate it with video or text, c) easily search additional resources without leaving the context, d) automatically summarize some text and, e) most importantly, share one owns annotations with a group of friends.

A specific experiment was run in a middle school, involving a class as test case and another as control group. By focusing on possible differences in the learning effectiveness when using such software, it emerged that our data do not show a meaningful signal in such respect. However, the teacher reported a good degree of enthusiasm among the students who used the system.

To better quantify students' reaction, they were asked to fill in a questionnaire. Questions regarded two aspects. The first one was about the usability of the system (user friendliness, graphical aspect, absence of technical problems, logical organization of the functions, ease of learning to use it): on a 5 point Lickert scale, the mean was 4 and the median 4.2. Results were even better on the second aspect: we asked if they liked sharing annotations with their peers, if they liked adding videos, images and web resources to the original text, if the tool made studying more fun and interesting, and if they would like to continue using the tool in future. The score had an average of 4.2, and a median of 4.7. Overall, only 1 student out of 14 (7%) gave an average score over all questions that was slightly on the unsatisfactory side (2,8).

Output of the focus groups

To obtain more precise indications about the perception that teachers had about the eSchooling project, we run a final focus group (earlier focus groups had been used to steer the experiment and system design). In the final focus group, there were 14 participants, coming from most of the schools involved in the experiment. The main significant contributions, which emerged from the discussion, were:

1) the eSchooling approach forces teachers to implement CBE. That in itself is considered to be good, but it requires more work for the teacher than continuing to use a traditional teaching approach;

2) the overall ambiguity of the Italian school system makes the approach pushed by the eSchooling philosophy difficult to apply. In fact, on the one hand the directives proclaim the need to adopt a CBE approach, but on the other hand, the final high school exam is still strongly knowledge-based rather than competence-based. Also the strong disciplinary imprinting, which has as a consequence a fragmentation of knowledge makes a CBE approach difficult, as some teachers have only a tiny number of hours per week in a class (such as 2 to 3);

3) it is necessary that a CBE approach involves all (or almost all) teachers in a class. Adopting CBE as an individual teacher without a multidisciplinary context and without any support by the colleagues dooms every effort;

4) although the eSchooling prototype is integrated with some other tools (e.g. Goggle Apps), the presence of distinct ICT tools creates some difficulties. For instance, teachers have electronic boards for recording traditional assessment results. Having a second, separate system for CBE activity is considered highly unpractical.

Among the other observations, most of teachers reported that they found useful to have to explicitly structure the competences. They also appreciated the analytic competence assessment reports produced by the prototype in form of radar diagrams. They found the learning style is profiling intriguing, even though they would like to be better trained to use and interpret the results. Finally, they reported that students typically like using digital platforms. Overall, in spite of a few shortcomings, both the overall idea and the implementation of the eSchooling project were evaluated positively.

Discussion

The accomplished experiment presents a mix of shadows and lights. On the one hand, the usage of the system appears to have been marginal, as evidenced by both the system log analysis and the participation to the community. On the other hand, teachers and school managers appreciated the idea and the way it was implemented. The students have expressed the same opinion, as it emerged by the interviews with the teachers and by the small sample that used the interactive e-book facility.

There might be several reasons for this. One is probably the fact that the experiment was not run with the complete system available since the very beginning of the project. As we mentioned, in the initial stage (November-December) only the possibility to prepare the plan was available. This explains the drop in accesses in December, and probably caused some early loss of interest by some of the teachers who originally agreed to participate to the experiment.

The criteria for choosing the teachers also strongly influenced the outcome. The early decision was to ask the involvement of only Math and Italian teachers, to firstly consolidate the system on the two subjects that are ubiquitous. However, later the interest of teachers of other subjects prompted to extend the set of competences. The original decision was orthogonal to the idea of including the majority of teachers of the same class, which the focus groups indicated as the correct choice.

Conclusion

We presented the results of an experiment run by introducing an ICT system for supporting CBE in a set of Italian high schools. We integrated information stemming from different sources: quantitative analysis of log files, multiple questionnaires run on different aspects of the experiment, feedback obtained via focus groups.

Although the results of the experiment are not quantitatively impressive, the collected multiple indicators allowed us to evaluate the system and to obtain precious indications on how the eSchooling group should approach future work. The main indication is to involve entire groups of teachers of the same class, rather than isolated ones. In this respect, the role of the school managers will be crucial. Since this will mean including also less motivated teachers, and teachers with a low level of ICT readiness, it may be important to provide a system interface, which is even more simplified and well guided than the existing one.

Another suggestion is to move in the direction of a tighter integration with other ICT tools such as the electronic board for recording activity, even when it is not competency based.

Finally, the accomplished experiment allowed to define and tune the evaluation methodology in view of a more extensive experimental study.

References

Cocea, M., & Weibelzahl, S. (2009). Log file analysis for disengagement detection in e-Learning environments. *User Modeling and User-Adapted Interaction*, 19(4), 341-385.

European Qualification Framework (2008). Retrieved from https://ec.europa.eu/ploteus/sites/eac-eqf/files/broch_en.pdf.

Hwang, H. K., & Ronchetti, M. (2014). Q-Book: multimedia annotation tool for e-books. *Proceedings of the World Conference on Educational Multimedia, Hypermedia and Telecommunications ED-MEDIA 2014*. Chesapeake, VA: AACE.

Lee, J., Podlaseck, M., Schonberg, E., & Hoch, R. (2001). Visualization and analysis of clickstream data of online stores for understanding web merchandising. In R. Kohavi & F. Provost (Eds.), *Applications of Data Mining to Electronic Commerce (*pp. 59-84). Springer US.

Raban, D. R., Moldovan, M., & Jones, Q. (2010). An empirical study of critical mass and online community survival. *Proceedings of the 2010 ACM conference on Computer supported cooperative work* (pp. 71-80). ACM.

Recc (2006). Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning, *Official Journal of the European Union* 06.05.2008 (2008/C111/01), 10-18. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:en:PDF.

Romero, C., Ventura, S., Espejo, P. G., & Hervás, C. (2008). Data mining algorithms to classify student. In R. S.J.de Baker, T. Barnes & J. E. Beck (Eds.), *Educational Data Mining 2008. Proceeding of The 1st International Conference on Educational Data Mining.* Montréal, Québec, Canada, June 20-21, 2008, 7-17. Retrieved from http://www.educationaldatamining.org/EDM2008/uploads/proc/full%20proceedings.pdf.

Ronchetti, M. Gris, R., & Chiozzi, G. (2015). eScholing: an ICT-based approach to Competence Based Education. *Encyclopaideia*, this number.

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