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Social Intelligent Learning Management System for Demanding Users

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Finally, I want to thank my family, especially my parents Michele and Rita, who supported me throughout and my sister Rosanna. They are great parents and I hope they can be proud of me.

ABSTRACT

With the ambition of providing teachers with a novel concrete tool called “Social Intelligent Learning Management System (SILMS)” for worldwide exploiting didactic contents to feature their courses, I faced the problem of creating a social platform with adequate functionalities to satisfy the teacher expectations.

This goal involved many disciplines and practices ranging from DB management, content management, social networking, till the exploitation of new cognitive systems in the thread of WEB4.0 services. At the same time my approach was much oriented to realize a real tool of concrete usage, still with distinguishably advanced features. Thus, starting with a well designed architecture I endowed it with key functionalities that become the stakeholders of the emerging social networks: 1) a quality system ensuring the value of the materials the users put in the platform repository as their contribution to the social business, 2) a recommender system based on either ontology assisted navigator or computational intelligence techniques constituting the principal tool to guide teachers along the assembling of materials into courses.

This work involved the cooperation of scientists in the mentioned disciplines, mainly at level of mentoring and discussing the best strategies. It also enjoyed contributions from foreign partners within the European Project NETT, which supported my PhD course and provided the lead case study as well. As a result we (me and the involved people) delineate an ecosystem where teachers exploit contents of a repository to which may contribute by themselves. They are encouraged in exploiting and contributing because the contents are of high quality; they are wisely assisted in the exploration of the repository by platform services yet under their full control; and they are variously reworded by this involvement.

This thesis resumes all this work, highlighting the innovative aspects and the experimental evidences. It consists of 6 chapters plus introduction and conclusions. The first two (chapters 2 and 3) are devoted to needs’ analysis and related state of the art. While a second block (chapters 4 and 5) deals with the platform design and implementation, the last two chapters are devoted to user experience and the mentioned cognitive tools employed in the realization of a recommender system which learns from the users how to better satisfy their inquiries.

The innovative contributions are reckoned in the Introduction, whereas a short appraisal of the work done and forewords are provided in the Conclusions chapter.

TABLE OF CONTENT

1. INTRODUCTION

1.1 Summary

This chapter introduces and summarizes the research project whose aim is to realize a new and original platform called Social Intelligent Learning management System (SILMS) for Demanding Users tailored to give teachers and trainers appropriate knowledge, skills, and innovative tools in the domain of the entrepreneurial education. To this end, the SILMS is created where teachers can formally or informally share experiences supporting their peers with technical training, along with theory and practical examples deriving from mutual and practical experiences in entrepreneurship. In this perspective, the platform through a systematic and intelligent use of metadata is able to offer an innovative social network specially tailored for teachers in order to valorize their competencies and fit their expectations.

1.2 Introduction and motivation

A constant remark of the EU commission [1]concerns the need to open educational paths in the schools at all levels towards entrepreneurship, in the aim of empowering students' economic and social skills, and leveraging their creative and innovative capacities, with the final benefit of creating new job positions. In the lack of a strong political strategy delineating a feasible feature of the modern society, entrepreneurship [2]is going to play a backup solution of the society illness. Hence we experience the birth of many initiatives promoting the entrepreneurship education, which are supported by both private companies and public bodies such as state ministries and European Community [3] directorates. A peculiarity of this discipline is that is not yet sufficiently mature for enjoying a well assessed corpus and structure. So, instead of a hierarchical solution in which few domain experts establish a well-defined didactic plan according to their authority, experiences and competencies, the solution we propose in these pages relies on a more “social-oriented” strategy where the educational learning process is created and shared bottom up by a community of teachers. Namely, we introduce a platform called Social Intelligent Learning management System (SILMS) tailored to give teachers and trainers appropriate knowledge, skills, and innovative tools in the domain of the entrepreneurial education.

The case study of the SILMS is an European Project called NETT[1] that is a project financed by European Commission, Enterprise & Industries DG with the aim of gathering a Social Network in order to improve the entrepreneurship teaching in the European education. This network turns around a platform supporting teachers in the formulation of courses on entrepreneurship and triggering a Social Community of people involved in the education on this. Extra services, named meta-services are integrated in the platform to satisfy the teachers' needs who are *demanding users* of the platform. They are demanding because they are accustomed to produce educational materials and to have clear ideas on the topics to be taught according to the level of preparation of the class to which they are intended. Moreover, particular care is taken over functionalities aimed at

[1] http://www.nett-project.eu/

maintaining the provenance of the educational material and at ensuring the authors' IPR (Intellectual Property Rights).

This chapter presents the main ideas and the current achievements in developing a teaching system in line with the mission of the research project in order to evaluate the impact of such platform on the teaching process carried out for providing entrepreneurial courses. Unlike other projects (e.g. Share.TEC[2]), which aims to support the exchange of individual learning objects, one of the key features of our model is to make more complex didactic structures available. Assuming the module as basic unit of a coherent aggregation of content suitable for teaching, our hierarchical structure of knowledge is organized in contents, modules, and courses. The design of a platform that allows the collaborative definition of contents in respect to this structure and to the teachers' skills, relies on three main challenges: how to certify the reliability and the origin of learning contents; how to guarantee their effective retrieval and reuse; and, how to support a community of demanding users.

The chapter summarizes the whole project according to the key words of the platform implementation: authoritativeness, efficacy and collaboration. It is organized as follows. Section 3 explains how our solution tackles needs concerning the quality of the didactic materials and the involved teachers' reputation. Section 4 describes a metadata-based search engine used to retrieve didactic contents that will be combined for creating courses. Section 5 describes its variant guided by cognitive tools. Section 6 describes the social oriented strategy implemented in the system that allows teachers to search, share and comment modules developed by other teachers. Section 7 describes technical aspects of our solution. Section 8 provides a comparison with the state of art and draws final remarks. Section 9 outlines the specific contributions of this thesis work.

1.3 Quality of teaching

As for the former, our platform is addressed to demanding users, teacher indeed, who are accustomed to produce didactic materials, to have clear ideas on the topics to be taught and to weight the quality of the material they face. Hence quality insured collaboration between teachers is the lead of the material production chain as depicted in Figure 1.

The idea relies on a strategy that sees the process of creation, verification, audit, publication and evaluation of a new resource (either content, module or course) as realized by different user profiles of our system: contributor, expert and master. This process is well studied and used in the context of publication of journal papers and I foster its integration with social network facilities in order to improve the quality of the outcome materials developed for entrepreneurial education.

[2] http://portal.share-tec.eu

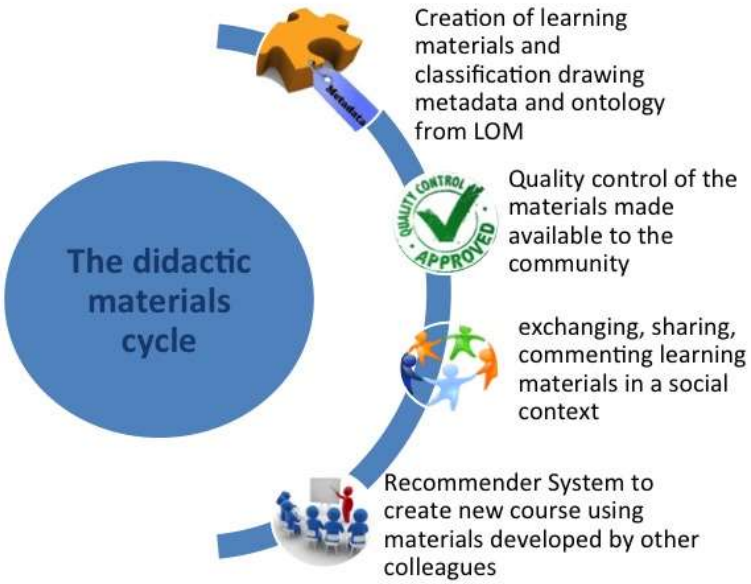

Figure 1 The didactic materials production cycle

When an user creates a resource, he assumes the role of contributor. The quality control of the created material is delegated to the Master of a specific disciplinary section (e.g. Economics or IT, that we denote as *knowledge area* in this context), which deals with the editorial control of the didactic material. To evaluate the quality of the candidate material to be published, the masters may require to experts of this area. Experts are "super" contributors that are elected to expert in a knowledge area according to their expertise and competencies.

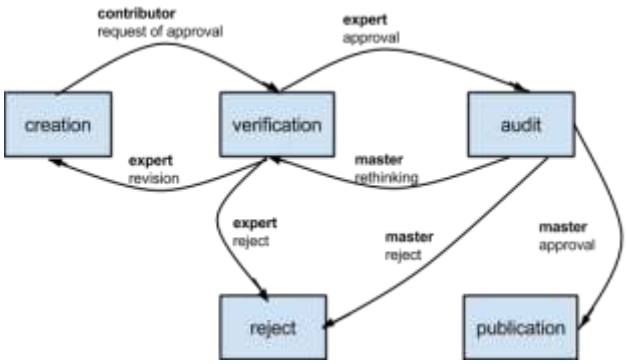

Figure 2 Resource life cycle

The state-diagram in Figure 2 reports the different states in which a resource can lie and who can decide its move into another state (with the corresponding motivation). The underlying process principal goal is to ensure the quality of the teaching initiatives design and realization. Once a resource has been created by a contributor, it is immediately available to the SILMS community but its state is defined according to precise quality policies. Namely:

- If the resource has been positively reviewed by an Expert and the Master, it is tagged with a green flag.
- If the resource is waiting for an evaluation, it is published as well, but tagged with a yellow flag.
- If the resource failed the review process, it is tagged with a red flag and yet remains available to be read.

This choice allows a wide dissemination of didactical materials that is relevant in a young discipline like entrepreneurship, tough guaranteeing the level of quality of the available materials.

1.4 Module Search Engine

The use of the above resources calls for efficient tools for identifying those of interest to a single visitor of the platform. It passes for a search engine based on proper metadata that are an excerpt of the IEEE standard LOM, and recommender system based on cognitive algorithms that is currently in a Beta version.

The base key facility of SILMS platform indeed is the search engine which offers the teachers the possibility of discovering modules to insert as part of the course that they are creating.

In the system each course, module or content is associated with metadata that describe the didactic materials and give meaning to them. We started by considering the IEEE standard LOM [4] .This standard provides a long list of metadata that can be categorized in: general, technical, educational, and classification. However, the standard is quite complex and articulated and we decided to consider a small subset of the possible metadata as reported in Table 1 that can be associated with specific contents, modules or courses. We remark that metadata for modules can be automatically extracted from their contents and thus multiple values can be specified for the same property (e.g. the language of the module is the union of the languages used in its contents). Analogous extraction can be done for courses.

Table 1 Metadata considered in the NETT platform

Metadata	Category	Description
Category	classification	knowledge area
Required Skills	classification	Skills needed to use the material (pre-requirements)
Acquired Skills	classification	Skills acquired after attending the module/course
Difficulty	educational	How hard it is to work with or through this resource for the typical intended target audience.

Format	technical	Technical datatype(s) of (all the components of) this resource
Keywords	general	Keywords
Language	general	Language of the resource
LearningResourceType	educational	Specific kind of learning object (e.g. exercise, questionnaire, slide, module, course)
Typical Range Age	educational	Target audience
Typical Learning time	technical	time requested for learning the resource

Thus metadata are the primary keys for retrieving contents within the platform. Namely, the three modes for exploiting a search are:

- *Metadata-based searching*. In Figure 3 a teacher is using the search module (part A of the figure) for discovering modules that he could insert in his course (part B of the figure) by means of the proposed metadata. However, at some point, a user would wish to find all the modules that pertain to a certain topic that may not have a proper metadata of its own, or may span many metadata. In this case he may shift to the second mode.
- *Full-text searching*. A teacher might wish to search modules relying on the occurrences of given words or concepts. To cope with this need, a full-text search is enabled on the title, summary and keywords associated with a module. This solution provides better performances (faster researches) and results are ranked according to the relevance to the query through proper weights.
- *Thesaurus-based searching*. The search engine is able to look for words that have a similar structure or some relations with the word being searched on, according to a controlled vocabulary.

1.5 Recommendation system for modules

Designing a successful knowledge-on-demand paradigm requires a dynamic support in terms of recommendation strategies that combine metadata representation of the learning material, the teacher's expectations, wishes, competences, and the indication coming from the community. A distinguishing recommendation approach in the SILMS platform is the use of learning algorithms to identify relations between the features of the platform contents that may prove, as well as indications suitable to the inquirer. Thanks to the massive use of metadata, the contents may be homogeneously identified through a vector of parameters (the metadata representation). In addition, thanks to the feedback of the previous users and the expertise of the Masters, a score can be associated with each composition of vectors in courses. This enables a dynamical decision tree procedure where, according to the current choice of the user, the system proposes branches of decision trees that may lead to satisfactory completion of the course, possibly listed in a monotone ranking.

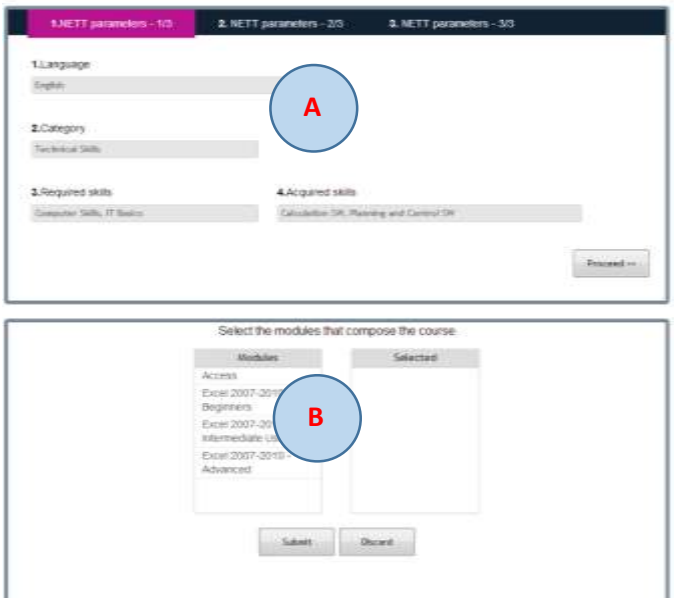

Figure 3 Search engine used to find modules to insert in a course. In the part A the user can set metadata. In part B a list of modules complying to the selected metadata is visualized

1.6 Social Network

Learning and training (in a sequence that recalls the egg-chicken dilemma) are social activities, especially when the learning objects are relatively new, hence not yet assessed in well established disciplines. Thus, the second pillar of our ecosystem is a social network where communities of teachers are fostered around each disciplinary sector. The objective is to transform a personal learning experience in a more collaborative and amazing one, obtaining better results.

To this aim, SILMS platform is equipped with standard social network tools (like blogs, chat, forum, messaging), plus the following advanced functionalities tailored for NETT project:

- *Definition of community.* Around each disciplinary sector it is possible to define specific communities of teachers. These communities are moderated by the Master of the knowledge area associated to each discipline sector. The objective of these communities is to transform a personal learning experience in a more collaborative and amazing one, obtaining better results. Moreover, thematic communities can be freely created by teachers.
- *Sharing of didactical materials*. Beside the official version of didactic materials published within the SILMS platform, there is the possibility to share non official material, without waiting experts' or masters' approvals.
- *Informal communication among users*. While sharing, teachers should receive private or public feedbacks that can help him/her in improving his/her materials. Moreover, communications among contributors/experts and experts/ masters can be conducted through social network facilities.

- *Teacher's Profile*. Teachers are called to create and edit their own profile, where personal experience or school education can be reported. This enables masters to promote contributors in experts relying on competence and credits. It also fosters social activities of users, who can get in touch with other teachers beyond the SILMS platform through either internal tools or external tools, e.g. Skype.
- *Followers*. Teachers can create a network composed by people with the same interests or experiences. Among them, people can follow a particular content of a user and consequently receive updates and news, keeping in touch with teachers with either the same skills or working, anyway, in the same field.

To summarize, the idea is that a social network is the perfect complement of our platform, which give rise to rich, efficient and fruitful communities of practice rooted on the common goal of favoring course design activities.

1.7 Technical features of the SILMS platform

As a result, we set up an entire ecosystem, sketched in Figure 4, where teachers are involved in two respects: i. as managers of the didactical material at various levels and ii. as members of a selected community of knowledge leaders.

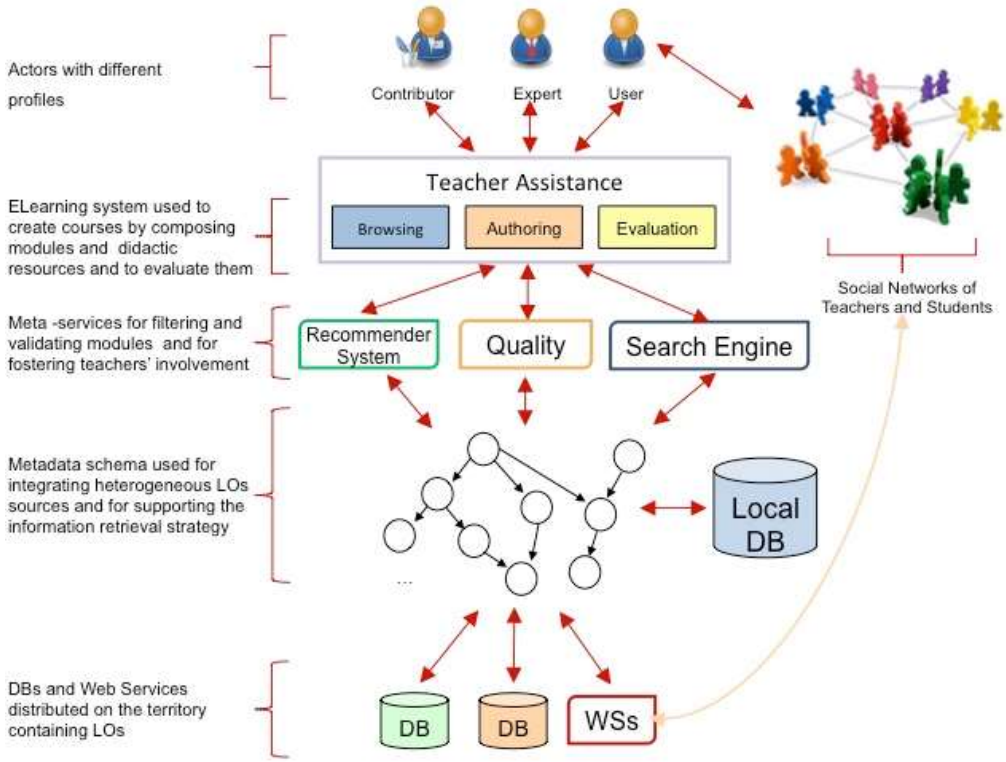

Figure 4 The NETT ecosystem

From a technical perspective, the system consists of a PHP shell piloting and empowering the customization of the Moodle platform, as for a Content Management System and

Mahara as for a nested Social Network. We based our platform on the Moodle system[3], because of its high diffusion within the school and a wide development community. The platform has been then integrated with social network features coming from Mahara [7] in order to introduce meta-services as previously described.

1.8 Concluding Remarks

The main goal of the thesis project is to offer a new opportunity for training teachers in the Entrepreneurship field using Social Intelligent Learning Management System (SILMS). The model is designed around a social environment able to enhance and enrich didactic contents proposed by all members of the community. In [5] numerous efforts have been made for training teachers in the context of technological innovations, for increasing the education quality [6] [7] [8] [9] and for developing teacher-training models based on self-learning techniques, adaptation and creation of Web-based educational resources [7].

Besides usual Web Learning Management Systems (LMS) such as Moodle or ILIAS[4], in recent years several models have been proposed for representing multimedia objects (such as Learning Objects - LO [9] , Open Educational Resources - OER [10] , SCORM [11]) and repositories (such as Merlot[5], Connexions[6], OpenLearn[7], ARIADNE[8], MACE[9], and Share.Tec[2]) that allow both the creation and publication of educational materials on the Web and the possibility of re-using and adapting such materials through Creative Commons licenses or by paying royalties for access to them. Unlike these projects, the SILMS platform aims to take advantage by an organizational model based on LOM, in order to both characterize the learning objects and to aggregate different data sources in a transparent way with respect to the entrepreneurship domain where we focus our research. Moreover, SILMS platform aims to promote a set of different actions to foster a better understanding of the importance of entrepreneurial discipline both as relevant component of a complete curriculum of students at all level of education and as valuable promoter of the future activities the young generations are going to carry out.

To this aim, the research project proposes a solution based on a strategy more social oriented where the educational learning process is created and shared bottom up by a community of teachers. Currently this community is working for populating the platform in order to set up a knowledge base for developing future usability tests with the aim of checking the system and the educational content offered by the members of the NETT community. Other meta-services are under designing for supporting a semi-automatic combination of modules by fitting the teacher's expectation according to his/her profile and educational background through the advice obtained from the recommendation system.

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[3] https://moodle.org

[4] http://www.ilias.de

[5] http://www.merlot.org

[6] http://cnx.org

[7] http://openlearn.open.ac.uk

[8] http://www.ariadne-eu.org

[9] http://portal.mace-project.eu

Ancillary materials concerning the project are reported in the website http://www.nett-project.eu.

This research project is not only an academic exercise; rather, it is a really operational tool at the service of entrepreneurship education teachers in Europe and worldwide. Indeed:

- The NETT platform is accessible to any people as a free tool at http://siren.laren.di.unimi.it/nett/mnett/
- Pilot and post-pilot courses have been delivered with teachers satisfaction
- Clips introducing the platform technical facilities have been produced and posted on Vimeo (https://vimeo.com/134550128 , https://vimeo.com/134550003)
- Over 2500 accesses to the platform, in spite of its youth and narrow scope and we estimated on over 400.000, either direct or indirect, beneficiaries of the NETT paradigm.
- A concrete exploitation plan has been devised and a start-up has been established, http://www.social-things.eu, having in the core business the maintenance of the platform for the next five years and the development of additional customer-oriented NETT-based services for its financing.
- A continuous maintenance and improvement of the platform is in progress in cooperation with the mentioned startup, to develop new functionalities such as the cognitive recommender system.

The entire thesis work is organized as follows. Chapter 2 focuses on the teacher needs, as they are collected through questionnaires and focus groups. Chapter 3 deals with the state of the art on learning/content management platforms and related social networks. While Chapter 4 acquaints the platform from the requirements perspective, Chapter 5 describes how these specifications have been identified and implemented. Then on Chapter 6 we evaluate the platform usability with various techniques. Finally, chapter 7 introduces a new recommender system to drive the user searches through a cognitive system. Chapter 8 draws conclusions and forewords.

1.9 Contributions

This thesis brings the following contributions:

1) Resume and introduction of research project, in particular the evaluation, design and development of novel and original Social Intelligent Learning Management System for demanding users (Chapter 1)

1. Valtolina S., Mesiti M., Epifania F., Apolloni B., Towards a Social E-Learning Platform for Demanding Users. In EDUCON2014 – IEEE Global Engineering Education Conference, Istanbul, Turchia, 2014)

2) Need's analysis focuses on the teacher entrepreneurship needs, as they are collected through questionnaires and focus groups. (Chapter 2) :

1. Apolloni, B, Galliani, G., Zizzo, C. , Epifania, F. , Crosta, L. , Cesareo, I. (2013) Socializing entrepreneurship, 17th International Conference in Knowledge Based and Intelligent Information and Engineering Systems - KES2013 - Published by Elsevier.
2. B. Apolloni, F. Epifania, M. Mesiti, M. Mesenzani, S. Valtolina, Educazione all'imprenditorialità: un cocchio per la Cenerentola dell'educazione Didamatica 2015 Genova)

3) The state of the art on learning/content management platforms and related social networks (Chapter 3)

1. Mesiti M., Valtolina S., Epifania F., Apolloni B., Metaservizi per la produzione collaborativa di moduli didattici in ambienti sociali. Rivista TD-Tecnologie Didattiche, numero 62, 2014
2. Epifania F. (2012). Blended learning in continuing education in medicine. In: DMS 2012 : the 18. International conference on distributed multimedia systems : proceedeings : Miami Beach, USA :, 2012, Skokie (IL): Knowledge systems institute graduate school,
3. Epifania F. (2012). Blended learning per l'educazione continua in medicina. In: Atti del MoodleMoot Italia 2012. Livorno, Italia, 2012

4) The requirements of the novel platform from (Chapter 4)

1. Mesiti M., Valtolina S., Epifania F., Apolloni B., Metaservizi per la produzione collaborativa di moduli didattici in ambienti sociali. Rivista TD-Tecnologie Didattiche, numero 62, 2014

5) The description of how this research project has been implemented (Chapter 5)

1. Mesiti M., Valtolina S., Epifania F., Apolloni B., Metaservizi per la produzione collaborativa di moduli didattici in ambienti sociali. Rivista TD-Tecnologie Didattiche, numero 62, 2014
2. Bruno Apolloni, Simone Bassis, Francesco Epifania, Carrie Tiffany Mammarella, Marco Mesiti, Marco Patti, Stefano Valtolina "NETT: un social e-learning system per l'educazione all'imprenditorialità" Didamatica 2014
3. Valtolina S., Mesiti M., Epifania F., Apolloni B., Towards a Social E-Learning Platform for Demanding Users. In EDUCON2014 – IEEE Global Engineering Education Conference, Istanbul, Turchia, 2014
4. Mesiti M., Valtolina S., Bassis S., Epifania F., Apolloni B., e-Teaching Assistant: A Social Intelligent Platform Supporting Teachers in the Collaborative Creation of Courses. In CSEDU 2014, 6th International Conference on Computer Supported Education, Barcellona, 2014

6) The evaluation of the platform usability with various techniques) (Chapter 6)

7) The analysis of the state of the art of RS and the introduction of a new and original recommender system to drive the user searches (Chapter 7)

1. Epifania F., P. Cremonesi (CISIS 2012). User-centered evaluation of recommender systems with comparison between short and long profile. 6. International conference on complex, intelligent and software intensive systems : Palermo IEEE Computer society
2. Paolo Cremonesi, Epifania F., Franca Garzotto (ACM AVI 2012). User profiling vs. accuracy in recommender system user experience.
3. B. Apolloni, S. Bassis, M. Mesiti, S. Valtolina, F. Epifania. (WIRN 2015) A Rule based recommender system , Salerno, Italy., Advances in Neural Networks: Computational and Theoretical Issues S. Bassis, A. Esposito, C. F. Morabito, E. Pasero (eds) Springer (in press)
4. B. Apolloni, S. Bassis, M. Mesiti, S. Valtolina, F. Epifania . (2015) A genotypic recommender system in e-books: NETT Entrepreneurship for Teachers

1.10 Author's Pubblications

The research efforts presented in this dissertation are the summary of 8 international publications plus 4 national publications, namely:

1) B. Apolloni, F. Epifania, M. Mesiti, M. Mesenzani, S. Valtolina, Educazione all'imprenditorialità: un cocchio per la Cenerentola dell'educazione Didamatica 2015 Genova
2) B. Apolloni, S. Bassis, M. Mesiti, S. Valtolina, F. Epifania. (WIRN 2015) A Rule based recommender system , Salerno, Italy., Advances in Neural Networks: Computational and Theoretical Issues S. Bassis, A. Esposito, C. F. Morabito, E. Pasero (eds) Springer (in press)
3) B. Apolloni, S. Bassis, M. Mesiti, S. Valtolina, F. Epifania . (2015) A genotypic recommender system in e-books: NETT Entrepreneurship for Teachers
4) Bruno Apolloni, Simone Bassis, Francesco Epifania, Carrie Tiffany Mammarella, Marco Mesiti, Marco Patti, Stefano Valtolina "NETT: un social e-learning system per l'educazione all'imprenditorialità" Didamatica 2014
5) Valtolina S., Mesiti M., Epifania F., Apolloni B., Towards a Social E-Learning Platform for Demanding Users. In EDUCON2014 – IEEE Global Engineering Education Conference, Istanbul, Turchia, 2014
6) Mesiti M., Valtolina S., Bassis S., Epifania F., Apolloni B., e-Teaching Assistant: A Social Intelligent Platform Supporting Teachers in the Collaborative Creation of Courses. In CSEDU 2014, 6th International Conference on Computer Supported Education, Barcellona, 2014

7) Mesiti M., Valtolina S., Epifania F., Apolloni B., Metaservizi per la produzione collaborativa di moduli didattici in ambienti sociali. Rivista TD-Tecnologie Didattiche, numero 62, 2014

8) Apolloni, B, Galliani, G., Zizzo, C. , Epifania, F. , Crosta, L. , Cesareo, I. (2013) Socializing entrepreneurship, 17th International Conference in Knowledge Based and Intelligent Information and Engineering Systems - KES2013 - Published by Elsevier.

9) Epifania F., P. Cremonesi (CISIS 2012). User-centered evaluation of recommender systems with comparison between short and long profile. 6. International conference on complex, intelligent and software intensive systems : Palermo IEEE Computer society

10) Epifania F. (2012). Blended learning in continuing education in medicine. In: DMS 2012 : the 18. International conference on distributed multimedia systems : proceedeings : Miami Beach, USA :, 2012, Skokie (IL): Knowledge systems institute graduate school,

11) Paolo Cremonesi, Epifania F., Franca Garzotto (ACM AVI 2012). User profiling vs. accuracy in recommender system user experience.

12) Epifania F. (2012). Blended learning per l'educazione continua in medicina. In: Atti del MoodleMoot Italia 2012. Livorno, Italia, 2012

1.11 Acknowledgment

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2. NEEDS' ANALISYS

2.1 Summary

This chapter discusses a statistical analysis emerging in the field entrepreneurship education, as a result of a survey conducted in the frame of the European Project NETT (Networked Entrepreneurship Training of Teachers, http://nett-project.eu) to define the users needs of the Social Intelligent Learning Management System. The analysis concerns both the quality of data and the emergence of some special patterns denoting some interesting features of the entrepreneurship perception and its teaching.

In the lack of a strong political deal delineating a feasible feature of the modern society, entrepreneurship is going to play a backup solution of the society illness [12]. People identify exciting businesses that may represent the seeds of modern enterprises, which, in turn, may constitute the real spring of the community life at various scales. In spite of the large potentiality of this new deal and of undoubtedly successful instances, young generations are not prepared to this challenge, since older ones did not elaborate a supporting cultural tissue. Hence there is a birth of many initiatives promoting the entrepreneurship education, that are supported by both private companies and public bodies such as state ministries and European Community directorates. These respond to a specific target of the European commission, as synthesized in [3]:
Demographic groups that are underrepresented within the entrepreneurial population and especially founders of startups are young people, women, disabled and/or migrants. Europe has to open up for them paths into entrepreneurship to create for them jobs, empower them economically and socially and leverage their creative and innovative capacities. These paths should be sensitive to the needs of different groups, their expectations and their norms with regards to how advice and information is delivered and received. Actions should be based on an integrated support scheme that promotes human capital, as well as providing financial support. Besides specific activities adapted to the needs of each of these groups, they should all be included into entrepreneurship training programs that are designed and offered in partnership with education and training providers, youth organizations, mainstream business advisers and financial institutions.

A first step to realize SILMS platform is a quantitative small scale survey to collect and analyze the training needs of primary and secondary school teachers together with some university and vocational education teachers and to capture the initial understanding of specific countries [13]In the next sections we will discuss the results of this survey as it has been carried out in the Milano area (in Italy). Namely, in Section 2 we introduce the questionnaire used for collecting data, in Section 3 the emerging general cadre in Europe and in Section 4 their specialization to the Italian environment. Conclusions are drawn in Section 6.

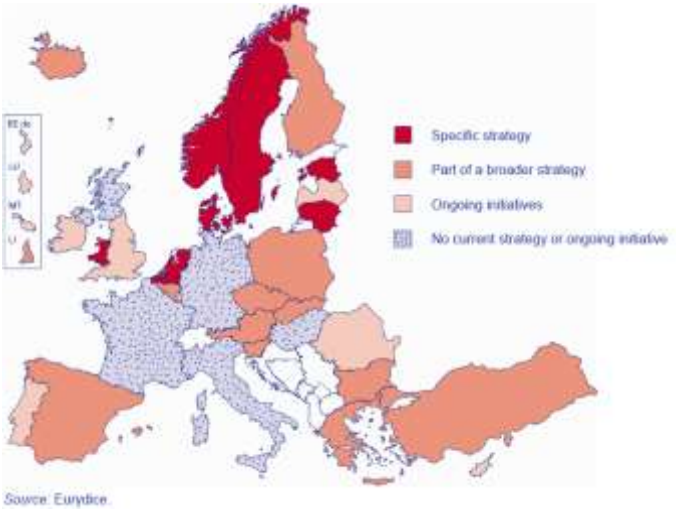


Figure 5 European strategies to teach entrepreneurship

2.2 The questionnaire

The map in Figure 5 characterizes the states with respect the national/regional strategies and initiatives to the implementation of entrepreneurship education into general education in the period 2011/12. In order to have a blow up on this scenario, a questionnaire has been submitted to 89 people teaching in different contexts, as for state, school type, teaching subject and experience. People were well balanced, as for gender, instruction and teaching experience. The aims of the survey were:

1. To get a deeper understanding of the training needs of primary and secondary school teachers together with some university and vocational education teachers in entrepreneurship education.
2. To collect and analyze the training needs of primary and secondary school teachers together with some university and vocational education teachers in the specific area of entrepreneurship in Italy.
3. To identify the most appropriate active learning methods which can be applied for effective and efficient of entrepreneurship education.

It was decided using the same form for all interviewees, independently of their specific teaching fields and aims. On the one hand, this decision penalizes the depth of some queries; on the other one the uniqueness of the source allows for drawing statistical conclusions in spite of the short number of answers. Therefore a set of 18 question has been formulated in order to jointly answer to the following questions:

	Skill / Capability	The importance of the skill for the entrepreneurship	Would this skill should be a part of learning process in entrepreneurship	How prepared are you for teach this topic	Would you need to improve the knowledge and skill to teach it
1.	**Entrepreneurial**				
2.	Entrepreneurial Traits/Behaviors				
3.	Leadership				
4.	Personal Assessment				
5.	Personal Management				
6.	innovative thinking				
7.	creativity				
8.	ability to see opportunities				
9.	**The basic business knowledge and skills**				
10.	Business Concepts				
11.	Decision Making				
12.	**Communications and Interpersonal Skills**				
13.	Ethics in Communication				
14.	Group Working Relationships				
15.	Dealing with Conflict				
16.	team working				
17.	**Economics**				
18.	Financial Literacy				
19.	Money Basics				
20.	Personal Money Management				
21.	Accounting				
22.	**Professional Development Career Planning**				
23.	.....				

Figure 6 The first 23 lines of the question 15 query table

What are the demographic data of teachers participating in research (age, sex, education level, teaching experience, school type, teaching subject, besides name and e-mail address) (questions 1 to 8)

2. What do teachers think of their competences on entrepreneurship education and his possible improvement (questions 9 to 14 requiring marking a score from 1 to 5, where question 14 splits into 4 queries).

3. A two way table where on the row are listed Skills / Capabilities which are questioned along the columns with respects 4 aspects (question 15):

(a) The importance of the skill for the entrepreneurship [10]

(b) Would this skill should be a part of learning process in entrepreneurship?

(c) How prepared are you for teaching this topic?

(d) Would you need to improve the knowledge and skill to teach it?

See Fig. 6. In synthesis, the first two points refer to the perceptions that interviewees have about the skills required for teaching entrepreneurship, while the remaining two points relate to the perceptions that interviewees have about the need of being trained on those skills, and their capability of using them. There are 53 queries in the list, which may be gathered in 5 almost equally populated clusters: 1. management skill; 2. economic skill; 3. communication capabilities; 4. personal initiative; 5. technical skills. Each cell of the table has to be scored according to a 5 points Likert Scale that provides

[10] 1with the term skills in the questionnaire we refer to all the capabilities people think could be useful to entrepreneurial activities; thus it depends on the category of entrepreneurs (chemical skills, or computer skill, etc). See the above discussion on the option for a unique questions' form.

an evaluation from 1 (less important) to 5 (very important) with a neutral value of 3 in between.
4. Didactic versant splits in two family of questions: the one concerning the education curricula of future entrepreneurship (question 17), the latter the didactic tools (question 18), to be filled up only by teachers on entrepreneurship education (question 16). Each family list 10 questions requiring a 5 level evaluation.
The questionnaire is available on line and it requires accreditation to access. In the following subsections we will examine the results of this inquiry from two perspectives: the quality of data and the emerging patterns.

2.3 The general cadre

The questionnaire has been submitted in Bulgaria, Italy and Turkey with the participation of 89 teachers (36 male and 53 female). The 47 of them have bachelor's degree, 23 have Masters and 18 have PhD degree. Only one teacher has high school degree. The mean of age was 45 years old. While the youngest group of teachers was in Turkey, the oldest group was in Italy. The 46,4% of interviewees teaches entrepreneurship education.
On the question whether they feel competent in entrepreneurship, only 14% of them felt "very high" competence; 27% feels highly competent in entrepreneurship; 39,8% feels "no competence" or "low competence" in entrepreneurship.
According to 85% of the interviewees, entrepreneurship education is important or very important for their students. However, only 48% of them want to participate in courses on training on entrepreneurship.
In particular, 33% of teachers find it "very useful" to attend an online training and 10,2% thinks that it is not useful at all.
Teachers also asked about which skills are important for entrepreneurship education. They indicated that the followings skills are the most important 10 skills in entrepreneurship: Decision Making, Communications and Interpersonal Skills, Team working, Innovative thinking, Personal Management, Risk Management, Group Working Relationships, Strategic Management Planning, Ability to see opportunities, and Personal Assessment.
According to the results, none of the teachers are "fully prepared" to teach listed topics. Teachers feel "slightly prepared" to teach following topics: Accounting, Daily Operations, Purchasing/Procurement, Simulation, Entrepreneurial and Drawing.
When they are asked about current entrepreneurship curriculum, only 28% of teacher thinks that current entrepreneurship curriculum supports good ideas and development. While 23% of teachers thinks that current entrepreneurship curriculum is helping students to create a new job, 28% of teachers thinks that current curriculum is inadequate in helping students to create a new job. Also 36% of teachers think that the current entrepreneurship curriculum is in line with the market reality and the 31% of the teachers disagrees.
According to data only 39% of teachers thinks that the current entrepreneurship curriculum does not adequately put students in real entrepreneurship environment and 51% of teachers think that the duration of current entrepreneurship curriculum is not enough to prepare the students to become entrepreneurs.

2.4 The Italian survey

Inside the Europe map shown in Figure 5, Italy appears among the null strategies countries. Still worse, neither national objectives related to entrepreneurship education can be found in national lifelong learning strategies as well as in general education and youth strategies which generally include a key competences approach [1].
However, economic growth strategies often embrace entrepreneurship education. This entails that regional programs financially promote educational initiatives toward entrepreneurship (see for instance [14]) and ancillary actions, such as the IFS portal [15] created by the Italian Education Ministry to introduce students in the entrepreneurial world through a guided simulation of the main entrepreneurial activities. In summary, common people, students and teachers perceive the importance of this discipline both as relevant components of a complete curriculum of a student and as valuable promoter of the future activities the young generation are going to carry out. Thus, in the next sections we address the analysis of the above questionnaires specifically to the Italian interviewees.

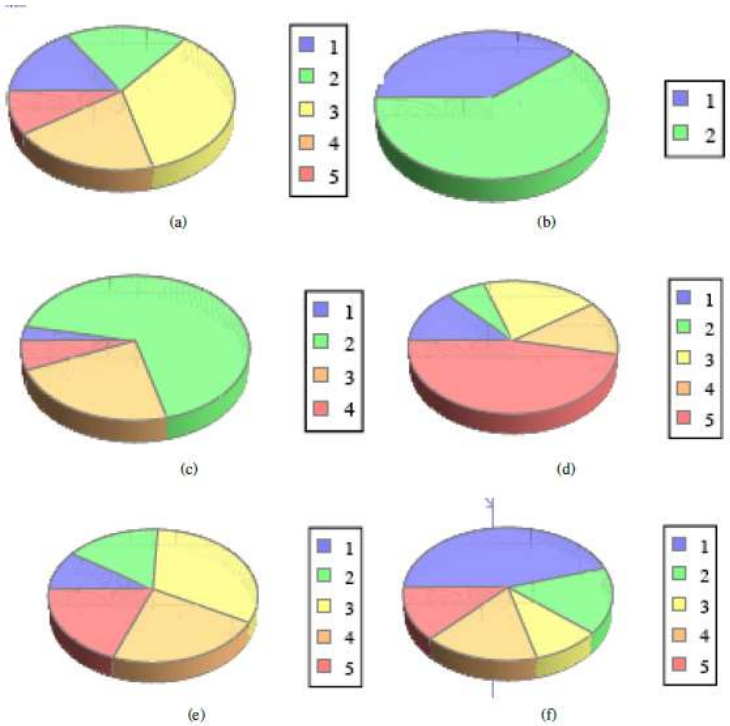


Figure 7 A synopsis of inquired people. a. quantized age (Ceiling[(age-25)/10)];b. gender:1-> male, 2-> female;c. instruction level; d. teaching experience in years x4 ;e. teaching grade level (c.,d., e.: same scales as in the on-line questionnaire);f. teaching

2.4.1 Inquired people description

The people distribution is shown in the six pie charts in Fig. 7. From these pictures we may conclude that people are: 1) well balanced as for gender, age and teaching grade level where they teach; 2) mostly bachelor graduated or higher, and 3) with a long teaching experience, 4) peculiarly, as for the teaching

filed, most are involved in humanities, but all remaining fields are well represented. Of course, 31 is a very small number, however the relatively large standard deviation of the data (1:29 averaged on the questions) says that we span a meaningful sample.

2.4.2 Overall trends and quality of the data

As predictable, the score histogram is strongly biased by the highest values. This is true both for the general questions (up to question15), and for the professional ones as well (questions 17 and 18), see Fig. 8

Focusing on the first category of queries – namely 221 queries: the 53 × 4ones of table question 15 plus 9 queries in questions 9 to 14, if we look at the single answers we see an enough variegated spectrum of marks (see Fig. 9). Namely, each bar reports the mean score attributed by people, where some particularly low values will be discussed later.

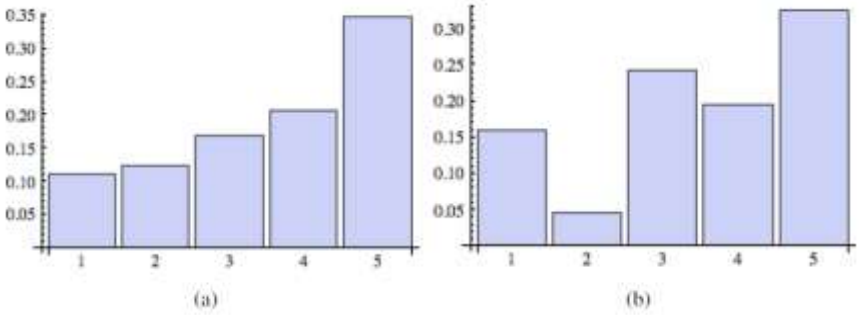


Figure 8 Histograms of the scores assigned to (a) the general queries of question 15 answers and (b) the queries for specifically experienced teachers (questions 17 and 18)(b)

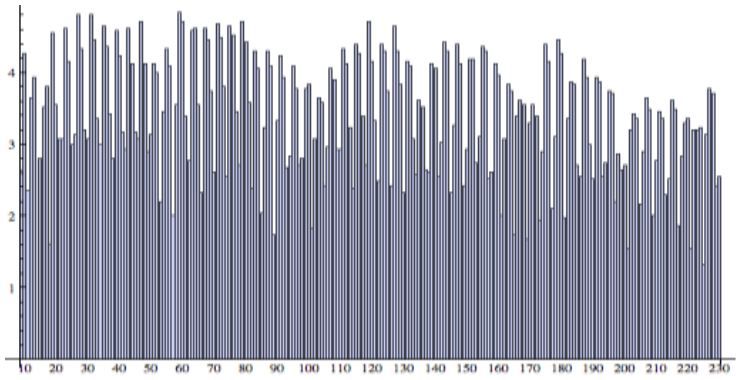


Figure 9 Barchart of the mean scores assigned to the single (220) general queries

2.4.3 General skills' appreciation

Looking at the mean score per each item of question 15 (i.e. grouping the score of the 4 questions heading the columns), as reported in Fig. 10(a) we may perceive some either tiring effect on the part of the interviewed people or their willing of issuing more discriminant judgments, which reflects in a decreasing trend with the questioning progress. This is accompanied by a complementary increase of the standard deviation (see Fig. 10(b)). Vice-versa, if we gather the queries per column, we obtain the graph in Fig. 11, which confirms the score bias when we refer to the importance of a skill and the

willing of teaching it to candidate entrepreneurs, while the teacher preparation and the willingness of improve his preparation on a given skill deserve substantially a uniform assignment of scores.

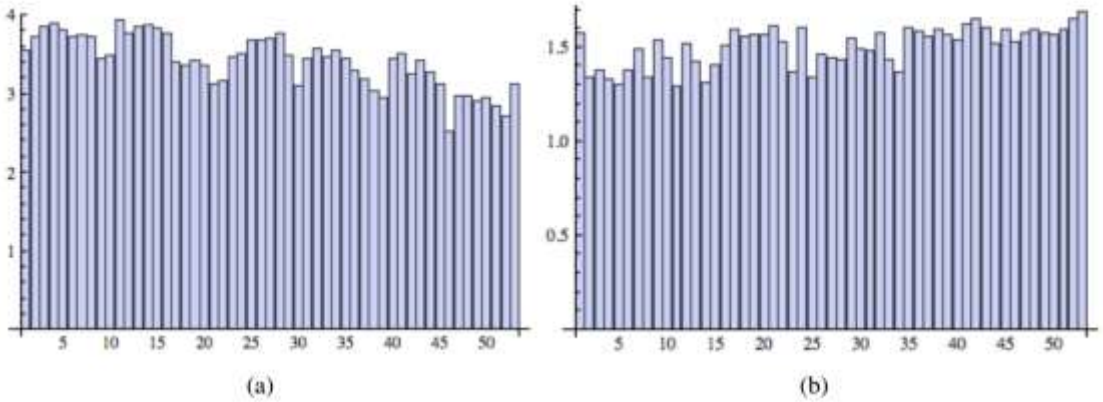


Figure 10 Average and standard deviation of scores per row items (53) in question 15

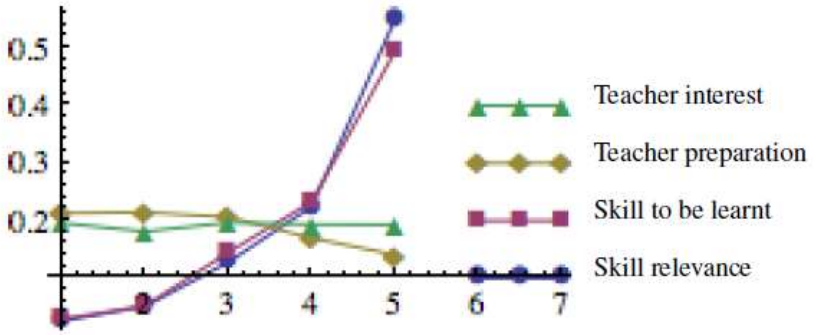


Figure 11 Score frequency distribution on skills' consideration. X-axis: scores (from 1 to 5, scores 6 and 7 are dummy); Y-axis: score frequencies within question 15. Curve labels: column heads in question 15

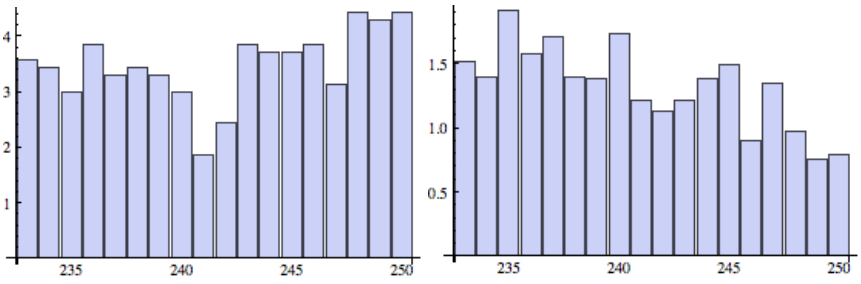


Figure 12 Average and standard deviation of scores per queries in questions 17 and 18

2.4.4 The answers of teachers on the field

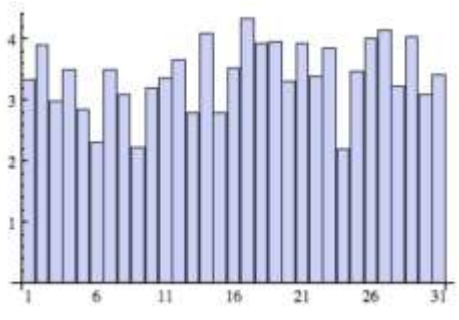
As for the more professional questions (17 and 18) the analogous graphs denote more articulated verdicts with a standard deviation decreasing with time (see Fig. 12).

2.4.5 Looking at the overall attitude of single people

Shifting our perspective on inquired people, Fig. 13(a) shows a rather variegate approach to the questionnaire. In particular Fig. 13(b) lists the features of those scoring less, in average, the questions (namely average less than 2.9). It emerges that all them are over 45 old, while variously distributed as for the remaining features.

2.4.6 Particular trends

We have 31 persons filling up the first part of the questionnaire and 7 persons completing the second part as well. Hence we cannot expect strong features emerging.



(a)

age	gender	edlev	exper	aclev	field
69	1	3	3	5	3
52	2	3	5	3	2
47	2	2	5	4	1
45	1	2	4	3	4
62	2	2	5	2	1
52	1	4	5	5	5

(b)

Figure 13 An overview on people filling up the forms. (a) barchart of the mean score for each people; (b) features of the 6 less scoring (in average) people

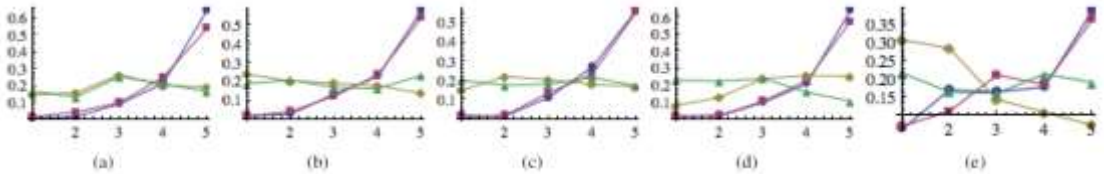


Figure 14 Score frequency distribution on skills' consideration, split by categories: (a) management skill, (b) economic skill, (c) communication capabilities, (d) personal initiative, (e) technical skills. Same notation as in Figure 11

	c1	c2	c3	c4
c1	1.	0.752632	0.310484	0.344696
c2	0.752632	1.	0.248107	0.430148
c3	0.310484	0.248107	1.	-0.256919
c4	0.344696	0.430148	-0.256919	1.

(a)

	c1	c2	c3	c4
c1	1.	0.91442	0.420008	0.40007
c2	0.91442	1.	0.428169	0.452145
c3	0.420008	0.428169	1.	-0.127661
c4	0.40007	0.452145	-0.127661	1.

(b)

Figure 15 Correlation table between the four columns in the query table of question 15. (a): all data; (b): referred to the sole category 5

In particular, as for the 7 responses, the average mark on items from 233 to 241 (concerning what is really taught) we observe no particularly enthusiastic answers, with a minimum concerning the amount of time dedicated to teaching entrepreneurship and the attention to the business plan. The most scored answer is rather a wish that the teaching activities promote entrepreneurship willing of the students. Answers to

question 18 items promote the usage of role games and simulation in general while distrust in the teacher centrality.
As for the most populated answers (question 15), the general trend seems following the importance with which the question lines have been allocated in the form (from the most relevance to the less one). Thus, management issues and instrumental issues (computer and electronic tools) prove less appealing than the human management aspects (actually the most easy ones, those no requiring rigorous education, probably). Per se, the general voices (queries 42 and 45) are well scored, a less benevolent fate is obtained by the single specifications of these voices, with a definitely bad score for the ability to draw picture with computer and reckoning abilities, but also to the capability of managing the day-per-day operations. As it emerges from Fig. 13(b), the most severe verdicts come from aged people, even though the low value of the correlation coefficient between mean score per person and its age (only -0.057) denotes a scarce significance of this trend.
Deepening the analysis w.r.t. the five categories: management skill, economic skill, communication capabilities, personal initiative, technical skills, we observe that the general trend: high score for relevance of the skill both in the entrepreneurship and its education, almost uniform score for preparation degree and improvement willing (with a slight bias toward low values in the latter), is maintained in all categories, with the mentioned general bias toward low scores in the last category (see Fig. 14). Focusing on the full score 5, we see that it is attributed to the skill importance with a decreasing rate moving from more humanistic to more technical skills. The personal implications, in terms of what teacher already knows and what want to improve, is almost the same along the categories, apart the fifth one. In essence, interviewees denote the same picture as for the management, economic and communication skills (apart the mentioned decreasing of the full rank rate). The category ”personal initiative” is similar but with an obvious decrease of willing of improving willingness (as for the initiative, either you know it or not). Finally, as for the technical skills there is a general lack of confidence of the interviewee with the technical tools, not adequately paired, however, with a willingness of recovering this drawback. Namely the correlation table between the four answers to each query is the one reported in Fig. 15(a). While in Fig. 15(b) the analysis is specialized on category 5. Thus we may see that, on the one hand correlation between columns 3 and 4 are the sole negative one, and that their values in case of category 5 are relatively low in absolute value (actually the lowest among the categories).
Coming back to the first questions to interviewees, Fig. 16 denotes that:

- the importance of student entrepreneurship education is high but not uniformly maximal (average 4.26 over 5)
- the willing of developing competence in entrepreneurship is neutral (average 2.65 over 5), though the perception of benefiting of web teaching within an international community is higher (average 3.79 over 5)
- where the best evaluated sharing opportunity within a web community is represented by the best practices (average 3.80 over 5) and teaching material in general (average 3.51 over 5).

- question 14 has not be evaluated per se (score 0) since scores have been attributed to the queries 15 to 18 into which it splits.

where all these evaluations are expressed with similar standard deviation.

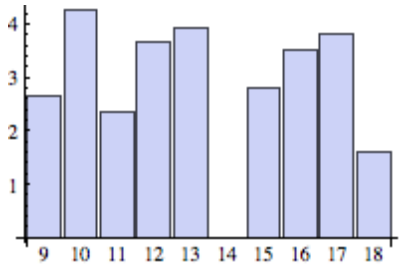


Figure 16 Scoring (in average) the favor of the teachers toward entrepreneurship education

2.5 Conclusions

Entrepreneurship is a people capability which has not uniquely coded by a well assessed discipline. For instance, the definition of entrepreneurship education emerging in [16] is the following: ”All activities aiming to foster entrepreneurial mindsets, attitudes and skills and covering a range of aspects: such as idea generation, start-up, growth and innovation”. In another document, the European Commission highlights that: ”Entrepreneurship education should not be confused with general business or economic studies, as its goal is to promote creativity, innovation and self-employment” [17] . Actually, our questionnaire complies with the list of skills assumed to be necessary in this document. However, the interviewees’ answers denote different appreciations of these skills and the way of teaching pupils them. Thus, apart from some habit notations, as a results of this survey we may quote a rather humanistic vision of entrepreneurship which privileges some rather natural people attitudes, such as initiative and communication capabilities, in diminution of technical skills – ranging from reckoning to computing technologies – requiring a deeper discipline which, in turn, at moment is lacking a well assessed framework. On the one hand this trend is not unexpected. Vice-versa it is compliant with the current European way of life. On the other one the reduction of the vagueness of the above framework we assume to go at the same pace of the improvement of the theoretical approaches to deal with fuzziness in sciences. The platform in the core of the NETT project should contribute to this progress in the general thread of modern social network emerging functionalities, namely by collecting real life didactic instances and fuzzy feedbacks on their solutions on the part of the social community members. The results of the discussed survey push us to stress the technical aspects of the entrepreneurship success story, however in a way that may prove compliant with the more soft expectations of the project target people. In short, we cannot expect to formalize a recipe for the entrepreneurship success; we will work to render the success more probable and reliable through dray statistics on the success story and their operational interpretation.

3. THE STATE OF THE ART

3.1 Summary

This chapter provides an overview of the main e-Learning Management Systems and Social Networks that are currently available and that could have constituted a starting point for the development of our SILMS platform, respectively in Sections 2 and 3. After a comparison of the various platforms and tools , we give the motivations for the choice of Moodle and Mahara for our scope.

3.2 Analysis of E-learning Platform

The number of e-learning systems has constantly been increasing during the past years as a lot of companies, faculties, universities and other institutions developed systems for common or personal use. Therefore, it is practically impossible to set up a complete list of e-learning systems. The following list includes some of the systems most frequently used in e-learning [18] .

- LRN [19] is an open source e-learning and community building software. Today, the software is supported by a worldwide consortium of educational institutions, non-profit organisations, some industry partners and open source developers. LRN is built on the top of OpenACS (Open Architecture Community System) [20], which is a toolkit for building scalable, community-oriented web applications.
- ATutor [21] is an open source system supporting learning and content management and specifically considering accessibility and adaptability issues. The first prototype was released in 2002 after the evaluation of its accessibility with people with disabilities. Several features are planned for the near future, including a barrier free authoring tool and a streaming media server.
- Blackboard [22] was founded in 1997 and provides course and content management systems, collaboration tools and a number of other services. It is one of the most popular and successful commercial e-learning systems.
- Bodington [23] is an open source LMS specialized on higher and further education developed by the University of Leeds. Bodington uses the metaphor of “buildings”, “floors”, and “rooms” to structure the Virtual Learning Environment (VLE). The main target is to be pedagogically flexible.
- BSCW [24] (Basic Support for Cooperative Work) is a commercial shared workspace system mainly supporting advanced document management. Additionally it offers group and time management facilities as well as communication features like discussion boards, annotations and surveys.
- CLIX [25] is a commercial LMS developed by the *imc* (information multimedia communication) AG. It is available in different releases especially suitable for several different application scenarios.
- Dokeos [26] is a quite complex e-learning and CM system and evolved out of the LMS “Claroline”. Most parts of the software can be downloaded for free, whereas others are offered on a commercial basis. In terms of adaptiveness,

Dokeos provides progress-based learning paths (teachers may define prerequisites for items).

- Ilias [27] is a service-oriented open source LMS. Its first prototype was developed in 1998 at the University of Cologne. In 2000 Ilias became an open-source software. Currently, it is developed by a collaboration network of several universities and companies.
- InterWise [28] is a commercial conferencing and collaboration tool. It provides mainly synchronous possibilities of interaction, including audio and video conferencing, desktop sharing, instant messaging, whiteboard, etc. Although it is not a traditional learning platform, rather a conferencing tool, its main focus lies on e-learning (primarily in companies). InterWise provides virtual classrooms with possibilities going further than those of usual conferencing systems, e.g. by implementing different roles and the possibility of posing questions and receiving statistics on the answers.
- Moodle [29] is a very popular free Course Management System (CMS) developed in 1990. In 2003 the company moodle.com was established to provide commercial support, managed hosting, consulting and other services. Since 2005 there is a fixed team of lead developers employed by Moodle, in addition to a large community of developers and supporting organisations contributing source code, ideas, etc. to the project. The general design tries to consider pedagogical principles and learning theories..
- The OLAT [30] (Online Learning And Training) project was started in 1999 at the University of Zurich. OLAT is a free LMS that is, since 2001, officially supported by the IT Department of the University of Zurich. In 2004 OLAT became open-source. Today further development is still carried out by the University of Zurich, whereas commercial support for the LMS is offered by various companies.
- OpenUSS with Freestyle Learning [31] was developed by the University of Munster (starting in 2000). According to the website [31] “Freestyle Learning (FSL) and Open University Support System (OpenUSS) are specifications of Learning Content System (LCS) and Learning Management System (LMS). They provide J2SE, J2ME and J2EE reference implementations on those specifications”. OpenLMS is now also collaborating with OpenUSS.
- Sakai [32] is a service-oriented Java-based open source LMS developed in 2004 by the universities of Michigan, Indiana, Stanford and the Massachusetts Institute of Technology. They contributed their existing LMSs to the new e-learning platform. Later on, other projects and partner institutions joined the Sakai community and developed Sakai tools based on their products (e.g. OSPortfolio, Samigo, Melete). Today Sakai is developed by 116 cooperating organizations and funded via a partners program.
- WebCT [33] was a commercial Course Management System created in 1996 at the University of British Columbia. In 2006 WebCT was acquired by Blackboard, but it is still in use.

Figure 17 reports a comparison of the presented LMSs. In the rest of this section, a deeper analysis of the most widespread LMS will be presented, paying attention to the

main features that are useful to decide which platform is better for Social Intelligent Learning Management System in NETT case study.

	Bodington	Dokeos	Moodle	OLAT	OpenUSS	Sakai	AHA	Alfanet	ELM-ART	InterBook	KnowledgeSea	METOD	NetCoach
Learning													
Assignments – Choice	X	X	X	X	X	X	X	X	X	X		X	X
Assignments – Text	X	X	X	X	X	X	X	X	X	X		X	X
Assignments – Files	X	X	X	X		X	X					X	
Stored Evaluation	X	X	X	X	X	X	X	X	X	X		X	X
Glossary			X	X	X	X			X	X			X
Bookmarks	X			X									
Annotations	X			X	X								X
Search	X		X	X	X	X				X			X
Cooperation													
Forum	X	X	X	X	X	X		X					X
News	X		X	X	X	X		X					X
Email	X		X	X	X	X							X
Personal Messages			X		X			X					
File Management	X	X	X	X	X	X		X				X	X
Calendar	*)	X	X	X	X	X		X					
Polls	X	X	X	X		X							
Nickpage Authoring	X	X	X	X	X	X		X					
Collaboration													
Chat	X	X	X	X	X	X							X
Audio Conferencing		X	*)		*)	*)							
Video Conferencing		X	*)		*)	*)							
Whiteboard		X			X	*)							
Desktop Sharing					*)	*)							
Learning Management													
User Group Support	X	X	X	X		X				X	X	X	X
Creating Content Online	X	X	X	X	X	X	X	X				X	X
Importing Content	X	X	X	X	X	X		X	X	X		X	X
Stored Learner Model							X	X	X	X	X	X	X
Personalization	X	X	X	X	X			X					X
Adaptivity													
Adaptive Guiding							X	X	X	X	X	X	X
Link Annotation							X	X	X	X	X	X	X
Link Hiding							X	X	X	X	X	X	X
Adaptive Pres. Support							X	X	X	X		X	X
Standards													
IMS CP	*)	X	X	X		X		X					
IMS QTI	X	X	X	X		X		X					
SCORM	*)	X	X	X	*)	X	X'	X					
IEEE LOM		X	X	*)		X		X					

Figure 17 Comparison of Learning Management Systems (LMSs)
X means supported, *) planned to be included, ' extension of the original system

3.2.1 Moodle

Moodle (acronym for Modular Object-Oriented Dynamic Learning Environment) is a free software e-learning platform, also known as a Learning Management System, or Virtual Learning Environment (VLE). Since June 2013 it had a user base of 83,008 registered and verified sites, serving 70,696,570 users in more than 7.5 million courses with more than 1.2 million teachers. Table 2 reports the main Moodle characteristics.

Table 2 Moodle characteristics

Course Management	Cooperation and Communication
• Enrollment Settings • Learning Resource Management • Time triggered/Conditional Access	• Group Management • Awareness Feature (who is online?) • File Download • Wiki

• Learning Progress Tracking for Members • Online news and announcement (College and course level) • Online Calendar • Syndication (RSS or Atom newsfeeds) • External newsfeeds can be displayed in a course • forums, blogs, and other features can be made available to others as newsfeeds	• Internal email exchange • Moodle instant messages • Chat/Discussion Forum
Test/Assessment	**Evaluation**
• Question Types: Multiple choice, fill-in-the-blanks, numerical, matching, ordering, hot spot, essay • Quizzes and quiz questions, allowing import/export in a number of formats: GIFT (moodle's own format), IMS QTI, XML and XHTML. • Question Pools for re-using • Randomization of questions and choices • Online quiz • Learning progress control	• Question Type: Calculated, Description, Essay, Matching, Embedded Answers, Multiple Choice, Short Answer, Numerical, Random Short-Answer Matching, True/False • Personalised and anonymous surveys • Pools for question administration and re-use • Online report analysis • CSV and excel export of survey results • Grading
Learning Content / Authoring	**Administration**
• File Management (all formats) • Integration with other Content Management Systems such as Drupal, Joomla or Postnuke (via third-party extensions) • TCPDF library included that allows the generation of PDF documents from pages.	• Role administration (global roles, local roles, role templates) • User administration • Different Roles Privileges and possibility of customization • Authentication, using LDAP, Shibboleth, or other standard methods (e.g. IMAP) • PayPal payment • Several Graphical Themes • Multiligual Support • Statistics and learning progress administration

	• integration with other CMSs such as Drupal, Joomla or Postnuke (via third-party extensions), and with e.portfolio Systems like Mahara • Several plugins about: activities (including word and math games), resource types, question types (multiple choice, true and false, fill in the blank, etc.), data field types (for the database activity), graphical themes, authentication methods, enrollment methods, content filters • Interoperability: Moodle runs on Unix, Linux, FreeBSD, Windows, Mac OS X, NetWare and any other systems that support PHP and MySQL.

3.2.2 Ilias

ILIAS supports the learning content management (including SCORM 2004 compliance) and tools for collaboration, communication, evaluation and assessment. The software is published under the GNU General Public License and can be run on any server that supports PHP and MySQL. Table 3 reports the main characteristics of the ILIAS LMS.

Table 3 ILIAS Characteristics

Course Management	**Cooperation and Communication**
• Enrollment Settings • Learning Resource Management • Time triggered/Conditional Access • Learning Progress Tracking for Members • Member Gallery and (Google) Map • Course News and Announcements	• Group Management • Awareness Feature (who is online?) • vCard Export • File Sharing • Wiki • Internal Messaging • Chat/Forum • Podcasting • Etherpad/Edupad plugin
Test/Assessment	**Evaluation**

• Question Types: Multiple choice, fill-in-the-blanks, numerical, matching, ordering, hot spot, essay • Question Pools for re-using questions in different tests • Randomization of questions and choices • IMS-QTI Import and Export • Online exams • Learning progress control	• Personalised and anonymous surveys • Question types: Multiple choice, matrix, open answer • Pools for question administration and re-use • Online report analysis • CSV and excel export of survey results
Learning Content / Authoring	**Administration**
• XML-based learning document format, exports to HTML, XML and SCORM • SCORM 1.2 (Certified for SCORM-Conformance Level LMS-RTE3) • SCORM 2004 (Certified as LMS for SCORM 2004 3rd Edition) • AICC • OpenOffice.org and LibreOffice Import Tool (eLAIX) • LaTeX-Support • HTML Site Imp--ort • Wiki • File Management (all formats)	• Role administration (global roles, local roles, role templates) • User administration • Authentication CAS, LDAP, SOAP, RADIUS and Shibboleth • Individual layout templates / skins • Support for multiple clients • PayPal payment • Didactic templates • Statistics and learning progress administration • SOAP Interface

3.2.3 Docebo

Docebo [34] is a SAAS/Cloud platform for e-learning,. As of February 2012, Docebo has served approximately 300,000 users. Docebo was the recipient of 2.4 million euro in funding from the venture capital firm Principia SGR. Table 4 reports the main characteristics of the Docebo LMS.

Table 4 Docebo Characteristics

Course Management	**Cooperation and Communication**
• Enrollment Settings • Learning Resource Management • Learning Progress Tracking for Members	• Chat/Forum • User notifications via SMS or email • Videoconferencing, chat and forums • Messages, notices and notepad • FAQs, Help, Link Lists, Glossaries, Wikis, E-portfolios • Group management

Test/Assessment	Evaluation
• Tests and Surveys	• Personalised and anonymous surveys
Learning Content / Authoring	**Administration**
• Immediate loading of any file: Word, Excel, video, audio, etc. • SCORM 1.2 (Certified for SCORM-Conformance Level LMS-RTE3) • SCORM 2004 (Certified as LMS for SCORM 2004 3rd Edition) • Integration with: Google Apps, Google Apps Marketplace, Facebook, Twitter, Wordpress, Adobe Connect, BigBlueButton	• Role administration (global roles, local roles, role templates) • User administration • Reports by user and by course • PayPal payment • Statistics and learning progress administration • Cloud Technology and Mobile features • More than 25 languages are supported • Interfaces with HR and ERP applications such as SAP HR, Zucchetti, Lotus and authentication systems such as LDAP and Active Directory

3.2.4 Ada

ADA [35], the acronym for “Ambiente Digitale per l'Apprendimento” (Digital Learning Environment), is an open source e-learning system projected and developed by Lynx. ADA offers several services to managing and integrating multimedia online and offline courses. It provides didactical support, access to shared materials, and management activities of information flows. ADA is a virtual environment where people can meet and exchange knowledge, experiences, whose content is available just-in-time. Table 5 reports the main characteristics of the Ada LMS.

Table 5 Ada Characteristics

Course Management	Cooperation and Communication
• Access to didactic and structured materials; • Creation, publication and the fruition of new educational materials; • Possibility to project and realize courses straight online easily and intuitively; • Navigation filtered on the learning level • Internal Search Engine • Online Course and content creation • Virtual Classroom • Video conference • Conceptual Map	• Communication/dialog among different actors of a virtual community; • Functionalities of: search, tagging, comment; • Agenda and contact book; • Internal Message Exhange • Personal Diary • Lexicon • Private and public notification • Forum

	• Chat
Test/Assessment	**Evaluation**
• Tests and Surveys • Monitoring of fruition-learning processes and tutoring. • Possibility to choose between a lot of different types of exercises • Creation and change of the graphic map of content; • Monitoring of classroom and courses	• Exercises automatically corrected or corrected by a tutor
Learning Content / Authoring	**Administration**
• Immediate loading of any file: Word, Excel, video, audio, etc.	• Different role profiles. • Arrangement to the mobile fruition; • Possibility for all users to customize their interface; • Features for deaf students. • Multilingual Interface • Management of many indipendent providers

3.2.5 Comparison and Motivation of the Choice of Moodle

The literature research among the different open source LMSs existing on the market shows that the main features are similar. Moodle has been chosen because it's one of the most widespread in the world and it is supported by a great community: the Moodle Community, an open network of over one million registered users who interact through the Moodle community website to share ideas, code, information and free support. This community also includes a large number of non-core developers, with Moodle's free source license and modular design allowing any developer to create additional modules and features. This has allowed Moodle to become a truly global, collaborative project in scope. Indeed, the external plugins allowed implementing the majority of the platform requirements. Even if Moodle is not so "social", it can be easily integrated with other systems, such as Mahara.

In conclusion, because of the flexibility offered by Moodle, the integration with others systems to support the social features and the introduction of Intelligent Systems such as the search on Metadata, the Social Intelligent Learning Management System (SILMS) will offer a useful support to teachers.

3.3 Analysis of Social Network Platforms

In this section we provide an overview of the main social network platforms that are currently available and that can be used as starting point for the integration of social network functionalities within the SILMS. Their synthetic comparison is reported in Figure 18 (picture extracted from [36]). After providing a presentation of two of these platforms, we will provide the motivations for the choice of Mahara.

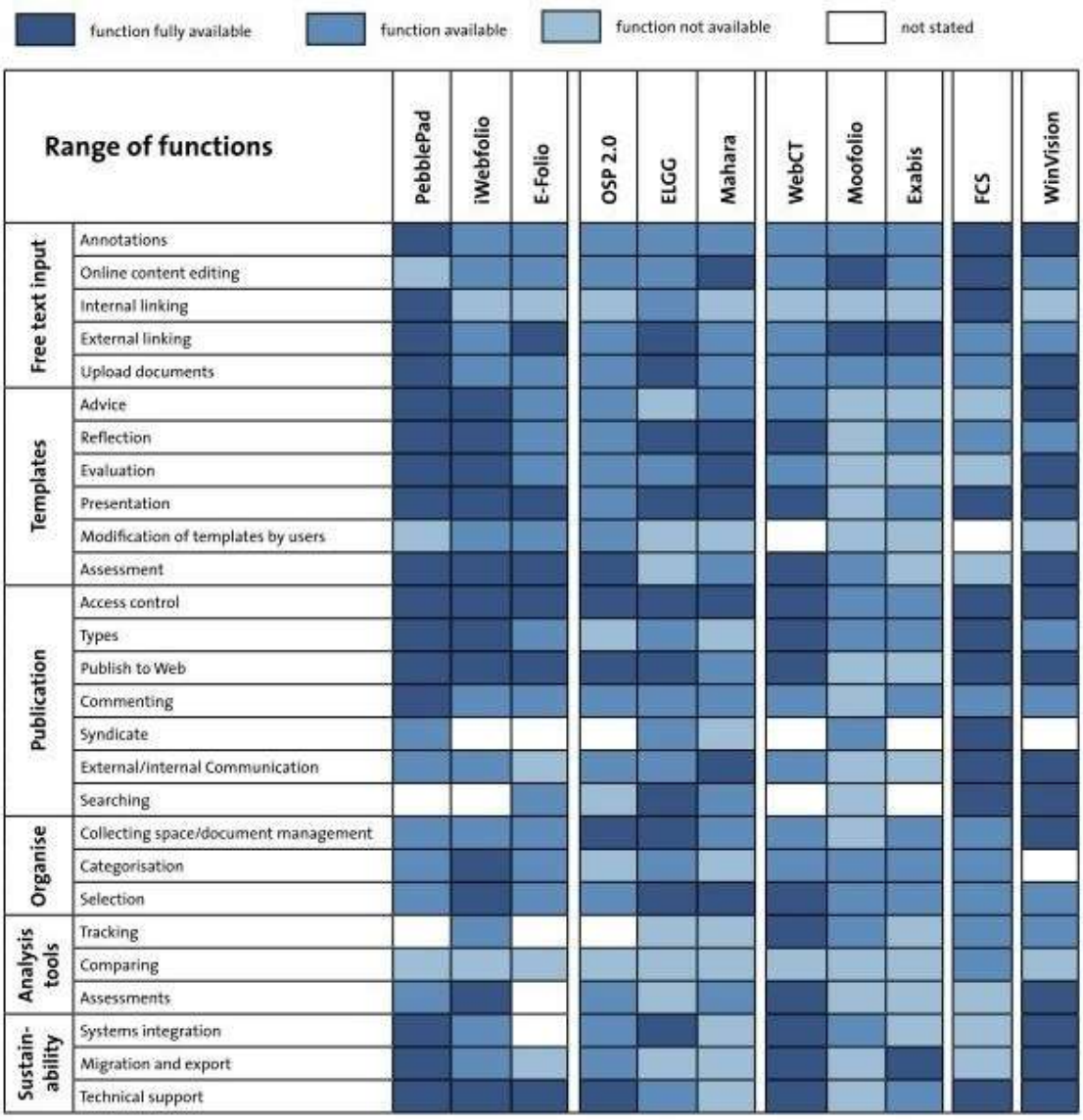


Figure 18. Range of function of e-portfolio software products (Salzburg 2007)

3.3.1 Elgg

Elgg [37] is an open source social networking software that provides individuals and organizations with the components needing to create an online social environment. It

offers blogging, microblogging, file sharing, networking, groups and a number of other features.
Elgg is a social networking framework as well. It provides the necessary functionality for running your own social networking site, whether publicly (like Facebook) or internally on a networked intranet (like Microsoft Sharepoint).
To run Elgg, we need to have our own web server and a certain amount of technical knowledge - or access to someone who does, like a system administrator.
Elgg comes with an advanced user management and administration, social networking, cross-site tagging, powerful access control lists, internationalisation support, multiple view support (eg cell phones, iPhone), an advanced templating engine, a widget framework and more. Most of the end user functionality in Elgg comes from plugins.

Table 6 Characteristics of the Elgg social network platform

Features from core and core plugins	**Built-in features**
• User, object, file and site management • Social graph functionality (relationships between users and other users, objects and sites) • Easy internationalization support • System-wide, tag-based searching across all content and users • Fine-grained access controls • Multiple views, allowing for mobile applications and embeddable widgets as well as the traditional web browser view • Plugin APIs • Powerful theming through the plugin API • RSS and FOAF for content syndication • OpenID and LDAP for user authentication • An extensible web services API, with results in JSON, serialized PHP or XML • AJAX through jQuery and user-definable callbacks • Easy extension for use with caching systems such as memcached, for increased system performance (experimental) • Use of multiple database connections for scalability (still in development)	• Avatar • Dashboard • Friends • Groups • Profile • Widgets Optional Plugins • Blogs • Bookmarks • File repository • Message board • Private messaging • Pages • Activity • Microblogging

3.3.2 Mahara

Mahara [38] is a fully featured web application to build an electronic portfolio. A user can create journals, upload files, embed social media resources from the web and collaborate with other users in groups. What makes Mahara different from other ePortfolio systems is that the user can control which items and what information (Artefacts) other users see within their portfolio.

In order to facilitate this access control, all Artefacts the user wishes to show to other users need to be bundled up and placed into one area. Within Mahara this compilation of selected Artefacts is called a View. Users can have as many Views as they like, each with a different collection of Artefacts, and intended purpose and audience. The user's audience, i.e. the people having the grant to access the View, can be added as individuals or as a member of a Group or Community. The ePortfolio owners create Views using a 4 step process and Views have the following features:

- The ePortfolio owners can receive public or private feedback on their View and Artefacts within that View.
- Users accessing a View can report any objectionable material directly to the Site Administrator.
- Users can add Views and Artefacts within a View to their Watchlist and receive automated notifications of any changes or updates.
- ePortfolio owners can Submit a View for Assessment by a tutor or teacher allowing for a snapshot of the View and associated Artefacts on a certain date.

Mahara includes a file repository which allows users to:

- Create folder and sub folders structures.
- Upload multiple files quickly and efficiently.
- Give each file a Name and Description.
- Manage their file allocation Quota.
- When uploading a file users must agree to a configurable Copyright disclaimer.
- Can extract .zip, .tar.gz and .tar.bz2 from within the files area.

A comprehensive blogging tool is provided in Mahara, where blogs and blog postings are considered Artefacts and may be added to a View.
The blogging tool allows users to:

- Create blog posts using a WYSIWYG editor
- Attach files to posts
- Embed images into postings
- Configure whether or not Comments may be received on their blog
- Create draft postings for later publishing

Mahara provides a social networking facility where users can create and maintain a list of Friends within the system. ePortfolio owners choose whether other users can add them to their Friends list automatically or by request and approval. An ePortfolio owner's Friends lists shows those Views to which they have been assigned access.
Mahara includes a resumé builder which allows users to create digital CV's by entering information into a variety of optional fields including:

- Contact and personal information

- Employment and education history
- Certifications, accreditations and awards
- Books and publications, professional memberships
- Personal, academic and work skills and
- Personal, academic and career goals

Within Mahara users are able to share details through a variety of optional profile information fields including:

- Preferred Name
- Student ID
- Postal address and contact phone numbers
- Skype, MSN, Yahoo & Jabber name
- Introduction
- Profile Icons images

Administrators can customise Mahara via a number of configuration settings, which include:

- Language packages and themes
- Virus protocol
- Session and account lifetimes
- Authentication methods
- Institution setup
- Core page editor
- Main Menu editor

In addition with the Modular plugin structure of Mahara, Artefact and Block types may be configured, disabled or enabled, according to the organisation's requirements.
Mahara has been designed as a web application with a plug-in architecture. This means it is possible to scale the application up by separating hardware for search, database, file storage and web servers.
It is also possible to replicate each of these operational components to further scale the system upwards. In addition Mahara is designed to:

- be load balanced across several web servers
- have a share file data from a centralised file server, and
- have a separate database server.

This hosting set-up has proven a scalability for similar systems like Moodle.

Mahara includes the following security features:

- Mahara automatically detects system settings that a pose a security threat.
- Session key handling code has been integrated with the core form/request APIs.

- Provides database abstraction that prevents any database injection attacks and input validation that prevents script injection attacks.
- User authentication can be tied to external systems such as student management systems or other databases such as their Student ID number.

Mahara offers the following functionalities to guarantee interoperability:

- Mahara includes an Import/Export system with Leap2A suport, and static HTML export.
- Users can place their views under any of the Creative Commons licenses.
- Mahara is built using PHP web scripting language and leverages PHP5's OO features.
- All plug-ins follow a consistent structure and inherit from a common base class (core functions of plug-ins are implemented once)
- Mahara currently supports plug-ins for Artefacts, Authentication and Search. Therefore interoperating with an existing product simply requires the development of a plug-in.

Interface with Moodle

Mahara provides a single-sign-on capability that allows users, at the option of the administrator, to be automatically logged into both their Mahara and Moodle accounts by providing a username and password at only one of these sites. Thus, the user can sign-on at Mahara, and click on a link to her Moodle account, or sign on at Moodle, and click on a link to her Mahara account.

The single-sign-on feature runs over an encrypted transport, and the user's passwords do not have to be shared between sites.

3.3.3 The Choice of Mahara

Even if Moodle offers some features that could be useful to support an exchange among the different actors of the platform (comments, mail exchange, chat, blog and forum), it doesn't seem sufficient to create a real community. Hence we referred to Mahara to recover the missing functionalities, given the easiness of its integration with Moodle.

As a general architecture, Moodle will support official exchange of materials that are validated by al expert board, Mahara provides the sharing of non-official materials (the artefacts) that solves the limit of experts' approval: in short time, a teacher can share didactic contents only with his/her contacts, without waiting experts' approval.

While sharing, teachers can receive private or public feedbacks that can help him/her to improve his/her materials.The inappropriate content can be straight notified to the

administrator who can immediately remove it. Teachers can also follow a particular content or another user and consequently receive updates and news, keeping in touch with teachers with the same skills or of the same field. Teachers can be considered on average experts in using technology, and they could need to manage a blog, to attach files to messages, to include images to posts and to configure comments that can be received on their blog.

In addition, as a reward of teachers' competence and their curriculum, each user can create a digital curriculum vitae, with contacts, personal information, work, school education, certifications, recognitions, publications and books, (interesting overall for academic teachers and search fellows), and personal skills. On their profiles, teachers can also share their Skype, MSN e Yahoo contacts, where they can keep in touch beyond the SILMS.

4. FUNCTIONAL SPECIFICATIONS AND REQUIREMENTS

4.1 Summary

This document describes the main functionalities of the Social Intelligent Learning Management System (SILMS) that are requested in NETT case study that, as already mentioned, has the main goal of supporting the teachers in delivering courses on entrepreneurship. This is realized by setting up an internet open platform in the cloud for exchanging contents, tools and methods between teachers on the topics related to entrepreneurship.

Scope of this section is to define the functional specifications of this platform. Namely, the platform must be able to support the content management, learning materials in general and the communication and networking among teachers.

The document presents the basic architectural outline of SILMS. It explains options and substantiates decisions. The outline of the architecture is based on general requirements and considerations. Hence, before going in details, this document first focus on a number of relevant initiatives and technologies that can be scanned for a good ideas, pitfalls and do's & don'ts.

The main objectives of the proposed SILMS should be:

- Identifying the proven state-of-the-art technological solutions and to use it for building the architecture.
- Defining an architecture that is interoperable with different ongoing initiatives in Europe. These include projects that deal with educational repositories (e.g. the OpenScout, Share.TEC [39], eContent+ projects) [40]as well as digital library initiatives (e.g. the European Library). The architecture must support multilingualism and combine the:
    - Repository with educational resources
    - Learning Management System for the either manually or automatically course creation
    - Environment to support the community of practice of entrepreneurial teachers where they can share ideas and resources and use the platform as a web 2.0 tool [41]

This section is organized in three parts. The main features of SILMS are listed in Section 2. Then, Section 3 deepens them from the requirements' perspective and Section 4 from the perspective of their implementation. Ancillary sections stay for appendices.

4.2 What makes the SILMS platform different

The SILMS features several characteristics that make it different from other learning and repository initiatives. They could be divided in two aspects: technological solutions and services.

- Technological Solutions:
  - Multi-language. The SILMS will permit to manage contents in different languages.
  - SILMS Knowledge Areas will be organized according to the following list, which represents the main topics in the entrepreneurship disciplines :
    - Entrepreneurial Vision
    - Personal Development
    - Communication Skills
    - Economic Skills
    - Technical Skills
  - Advanced features to recommend contents and to help the content retrieval. Indeed, the SILMS will include a recommender system enabling filtering and harvesting of the contents.
- Proposed Services:
  - Automated courses generation. The SILMS will create an educational course under user request.
  - Metadata harvesting and content transfer. The SILMS itself will contain some materials (for each published material will be sign the Honor code to remain in control of the suppliers or owners of digital content) and rely on metadata present in the participating repositories.
  - Implementation of the Open standards and specifications
  - Social Network to create a community of practice where users may exchange knowledge and Learning Object

4.3 System Requirements

SILMS has undertaken to build an advanced user-focused system that aggregates metadata describing teacher-related digital resources located Europe-wide. The system will offer personalized, culturally-sensitive brokerage for the retrieval of relevant digital content and will seek to nurture a more Europe-wide perspective among those working in and with the entrepreneurial teacher community. [42]

In order to meet these ambitious objectives, the SILMS system is endowed with a semantic layer that embraces the main components herein described, namely the Entrepreneurial Teacher Ontology (ETO) and the Common Metadata Model (CMM). This layer is designed to include a multilingual and multicultural dimension [43].

4.3.1 The basic requirements

The SILMS combines the Repository with Learning Resources, Community of Practice and Courses automatically created by user (Figure 19). The platform offers different Learning Activities and Tools for communication among users at the service of the courses.

The Repository is dynamically updated by the contributors and authorised users.

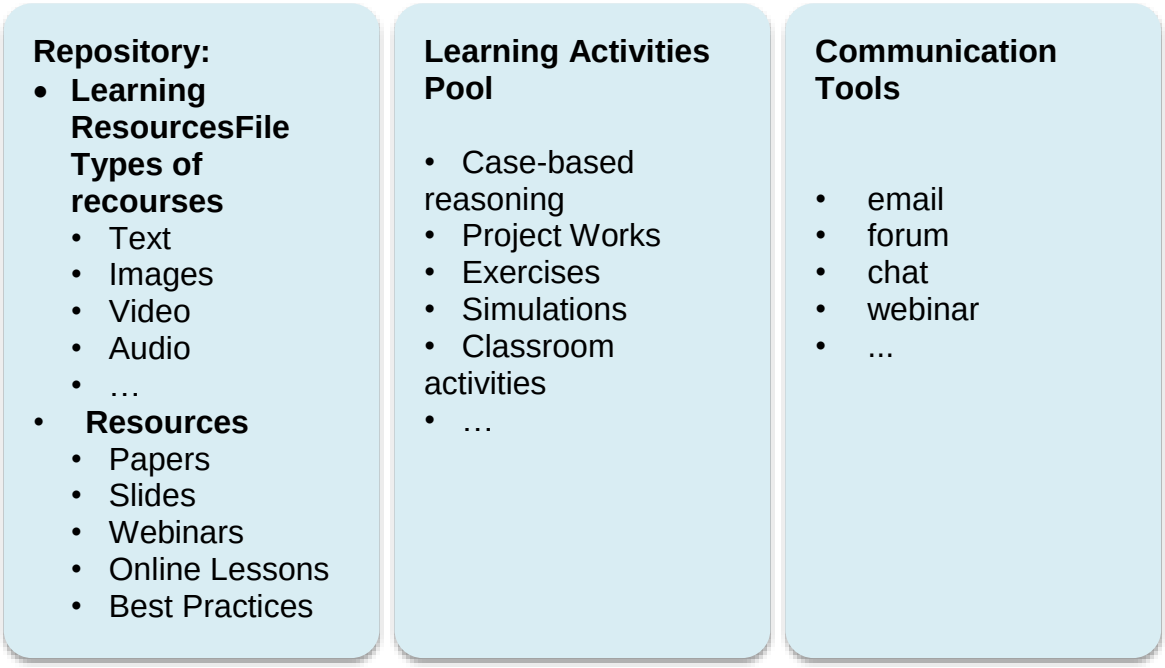


Figure 19 Main component blocks of the SILMS

The Repository is mainly structured by knowledge area using ontology, Materials for developing different competencies according the European Qualification Framework and type of recourses (Figure 20).

Each knowledge area will include the following sub-levels: Modules, Courses and Content Units.

Content Units are the basic entity of the SILMS and it could be represented by learning materials as simple definition, lessons, examples and learning activities (such as discussion forums, tasks and so on). All they are represented by different kind of files and authoring materials into the system. Contents will be accessed, managed and created according to an Access Control List.

Figure 20 Main repository metadata

The courses developed in the platform are created by the user request. There are two possibilities : either automatically or manually selection of the resources, activities and communication tools (Figure 21). The users should search and filter the repository information using the metadata.

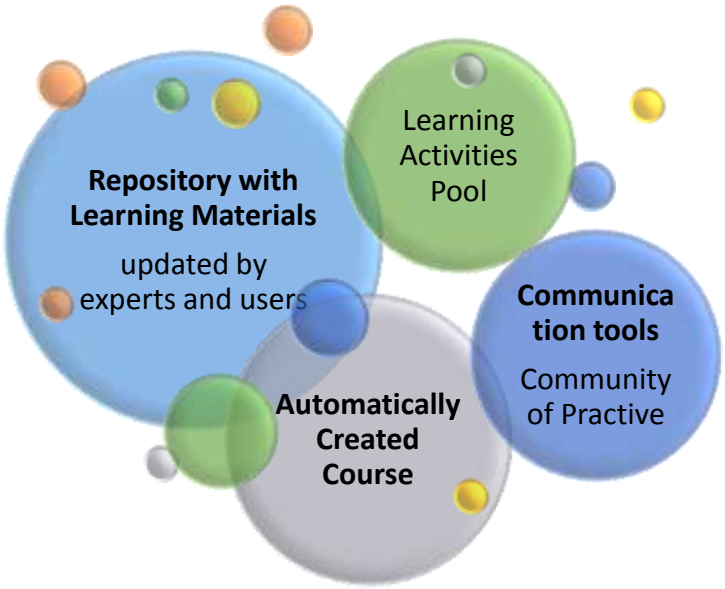


Figure 21 SILMS platform content structure

The third part of the platform is the Community of Practice that is based on the communication tools.

4.3.2 Access Control List

The SILMS is intended both for teachers' actually teaching entrepreneurship and for who is only interested on it, or who wants to find its application in his/her taught subject. Access Control List will be including the following roles:

- guest
- authorised user
- contributor
- expert
- admin
- master

The table 7 presents the roles' permissions in the different parts of the platform.

Table 7 Roles and Permissions

	Guest	Authorised User	Contributors	Expert	Admin	Master / Host
Repository						
Read published information	X	x		x	Manage the platform and users	
Upload information		x		x		
Approve published				x		
Community of Practice						
Read the Common Community Forum	X	x	X	x	x	x
Publish		x	X	x	x	x
Participate to the community		x	X	x	x	
Courses						
Participate in the courses		x	X	x	x	x
Creating the courses			X	x	x	x

4.3.3 Ontology

The internal structure of the ontology entity will be designed with a minimalistic approach in mind – the simplest structure that facilitates all required functionalities. Each ontology entity is represented as an individual node that (a) is interconnected with other nodes through relations and (b) contains a list of translations of the concept represented. [44]

Metadata encoded according to the Common Metadata Model (CMM) will be available in the SILMS harvested metadata cache, where it is accessible for the metadata migration facility. These metadata will automatically (re-) harvest and will migrate to instances that conform to the Entrepreneurial Teacher Ontology (ETO).

4.3.4 Metadata

There are a number of initiatives that are relevant and can be drawn upon for various purposes like design, architecture, code and modules. Some of these are open source; others are closed source but can still be useful in the design phase if design and architecture documents are public. Some of these are:

- Learning Object Discovery and Exchange (LODE). An IMS group that aims to facilitate the discovery and retrieval of digital resources. LODE's goal is to examine, select and adapt existing specifications.
- ADL's Cordra (Cordra). A repository registry allowing metadata searches. Cordra is not open source but design documents are available.

- Fedora Commons (FedoraCommons). A repository capable of federation.
- TENCompetence (TENCompetence). A European project about lifelong competence development.
- ARIADNE. The ARIADNE knowledge Pool System features an open source, standards-based set of reusable components for setting up repositories, federated search engines and harvesting.
- Meresco Suite (Meresco Suite) (Meresco Suite) (Meresco Suite). A metadata repository with a harvester/crawler and a search engine, used by Lorenet. The Meresco crawler is also capable of generating automatic metadata.
- LODE (IMS). Federations, Query Languages
- Metadata for Architectural Contents in Europe (MACE). An eContentPlus project that aggregates and enriches contents relevant for teaching in the domain of architecture.

4.3.5 Repository

Repository commonly refers to a location for storage, often for safety or preservation. So for SILMS, a repository is used as a storage place for content. Different repositories often specialize in a specific type of content. Some repositories can handle multiple content types (Audio, video, text). As some repositories come from a generic document management background and some from a content management background, they have different feature sets.

4.3.6 Harvesting framework

During the project, a harvesting infrastructure will be set up that serves multiple purposes:

- Getting a better understanding of the diversity of resources and metadata available in the SILMS.
- Setting up a central repository that provides search access to all resources in the network.
- Setting up the repository infrastructure important for the components.

The important parts for harvesting components are:

1. A SILMS content repository that offers access to its metadata.
2. A metadata validation component that gives a set of validation rules and a metadata instance for indicating whether a metadata instance is valid/complete or not.
3. A repository cache that offers write-access.
4. A harvester component that validates metadata instances using the validation service.

Metadata encoded according to the Common Metadata Model (CMM) will be available in the SILMS harvested metadata cache. Both the “Harvesting & validation framework” and the “Metadata Migration Facility” constitute the pillars of the SILMS architecture.

The ability to have search access to all resources will be a starting point for further developments in the network. Validating the metadata that can be retrieved will enable further identification of gaps and opportunities for further enhancements.

4.3.7 Content Management Workflow

The authorised users can publish the content into the SILMS platform.

Content status is: published, approved, rejected.

Once published the content could be reviewed by an expert. (S)He can approve or reject the material. After the review publisher receive the expert opinion. The rejected content will be deleted.

User - Publisher sign the authoring act if they publish the files or use authoring tool of the system to create learning recourses or activities. If the user insert a link to the existing online material the approval procedure is not necessary.

4.4 Features of the integration with SILMS

Types of Integration options

This section discusses the types of facilities that the integration with SILMS can offer; what they do and don’t do. It also includes the four headings for how this integration can manifest itself in SILMS.

Browse repository

This facility enable the users to browse the repository content and structures from inside SILMS. The browsing has been set up through the ontology (ETO).

Search/ filter the repository

The searching / filtering into the SILMS repository is based on keywords and metadata.
SILMS Private Files

One of the repository types in SILMS is the Private File. This enables each user for uploading and managing some private files.

This facility is made available to all users, students, teachers, admins and managers.

Users can perform a few tasks such as:

- Upload & Download files
- Create directories
- Zip directories
- Rename Files

4.4.1 Learning Management System

The SILMS offers the LMS. SILMS will be used for course creation: manually and automatically -on request. Training areas for teachers use will be activated and made available upon their request in order to be used in their classroom and on their daily teaching practice. Once the course has been created, the teacher can open it to the learners.

The Learning & Teaching philosophy of the SILMS platform will recall the Social Aspects of the platform and it will integrate them into the system according with a WEb 2.0 approach and the Recommender System of the platform described in the next section.

In the Learning & teaching area resources, forum, links and contents will be used and shared in each cohort with the support of a dedicated tutor. The online teaching and learning activities and assessment will be based on an interactive, collaborative and peer-to-peer approach to learning. Hence the presence of the tutor will foster both a formative and summative assessment works.

Teaching and Learning will be organized according with the five main Areas identified in the initial project research questionnaire, namely:

- Entrepreneurial Perspective
- Personal Development
- Communication Skills
- Economic Skills
- Technical Skills

4.4.2 Social Aspects

SILMS should enhance all the possible social aspects creating and supporting linkage and relationships among its participants coming from all over the world not only in the Training course area, but also in the Community Area. [45]

Basically Social Aspects are not only stressed by the introduction of Social Networks as links in SILMS but also creating in SILMS some typical features of the Social Networks themselves. Hence, the main purpose here is basically to create a new Social Network providing also a range of free or paid services useful for Entrepreneurship teachers. [46]

This means that:

1. In the Community area: features like forum, chat, email and so on are at the basis of the SILMS. A repository of resources will be designed together with the creation of tools that will help users to easily get in touch to each other namely:

- the possibility for each user to access his/her own board where latest postings from other connections and from SILMS administrators are visible,
- the possibility to create discussion groups and sub-groups,
- the possibility to upload, download and share some learning material (with a sharing feature for example),

- the possibility to subscribe to SILMS updates through an RSS function,
- the possibility to create “connections” or “friendship” with other users in the platform so that each users board can be shared and accessed,
- the possibility to access an area where new training courses are published and, at the same time, the possibility to subscribe for them,
- the possibility to access a job opportunity area with new job postings of teachers ‘interest,
- the possibility to have an “history “ on each user board according with their action on the platform,
- the possibility to receive email message outside the SILMS updating the users with the news of interest,
- the possibility to see the users online and to immediately connect with them through chat facilities,
- the possibility to access the News area of the Community where free information on events, conferences, new projects on entrepreneurship education may be easily available to users,
- the possibility to subscribe to a newsletter from the SILMS,
- the possibility to contact “experts” in specific domain areas through a public list.

2. In the Training area: features like forum, chat, email and so on are at the basis of the SILMS. There, a repository of resources will be designed for each specific Training Purpose together with the creation of tools that will help users to easily get in touch to each other namely:

- the possibility for each user to access his/her own board where latest announcement from the teachers are visible,
- the possibility to create discussion groups and sub-groups in order to exchange views and opinions in line with the activities of the course,
- the possibility to upload, download and sharing some learning material (video, audio, pdf, doc, ppt and so on), with a sharing facility allowing real-time shares,
- The possibility to receive email message outside the SILMS platform updating the users with the news of interest.

4.4.3 Recommender System

The SILMS should include a recommender system to present users [47] a suggested path to improve specific skills, according to their profile, personal interests, usage history and evaluation check-lists.

These features may foreseen the possibility for the user to:

- visualize all the new uploaded learning material or published material in line with their professional interests,
- visualize new registered users working in their professional field of work,
- visualize any event/news in line with their professional field,
- visualize any more recent training offer in line with their professional field,
- visualize those people who tagged similar content/items of their own.

4.5 Appendix 1 – List of criteria

Actual repository feature

- Web Upload/Download
- WebDAV/FTP/CIFS
- Check-in/out
- Version Control
- Workflow
- Metadata
- Categories/ Structures
- Taxonomies / Tagging
- Organisational Structures
- Audit Controls

Integration feature through SILMS interface

- Browse Through Categories
- Search via keywords/tags
- Copy File into SILMS
- Public link to file in repository
- Dynamic link to pull file from repository on -demand
- Private link to secure file in repository
- Upload File into repo
- Replace File in repo
- Delete File in repo
- Appears in File Picker
- Has a Custom Resource
- Has an Assignment Type
- Has a specific Block Options

4.6 Appendix 2 - Sources

The information gathered for this Chapter was taken from the various websites and documentation for each of the different services and the integration module as a best effort to detail the features and functionality. The following are tables of information with the links to the primary websites for each of the services. Where possible, confirmation of the features of the custom repositories was sought from the specific organisations and companies. Most responded with clarification, not everebody did it.

- Share.TEC - http://portal.share-tec.eu/
- OpenScout - http://www.openscout.net/
- External Systems Repositories Description
- Alfresco repository http://www.alfresco.com
- Box.net http://www.box.net
- Dropbox https://www.dropbox.com/
- Flickr http://www.flickr.com/
- Flickr Public http://www.flickr.com/
- Google Docs http://docs.google.com/
- Merlot.org http://www.merlot.org
- Picasa Web Album http://picasa.google.com/
- Amazon S3 http://aws.amazon.com/s3/
- WebDAV repository n/a
- Wikimedia http://www.wikimedia.org/
- YouTube Videos http://www.youtube.com
- NETT Project http://www.nett-project.eu/

5. DESIGN AND IMPLEMENTATION OF THE SILMS

5.1 Summary

Starting from the requirements outlined in previous chapter, this chapter provides an in-depth presentation of the functionalities that the SILMS offers and to describe the current implementation realized starting from the integration of the Moodle e-learning platform and the Mahara social networking system. The document describes the implemented functionalities by splitting them in bottom-up and top-down functionalities. The first kind functionalities have been realized by customizing the Moodle and Mahara systems, whereas the latter required the development of specific PHP codes and extension of the Moodle database.

The specific objectives of the chapter are:

- To introduce the SILMS paradigm in terms of contents inventory and retrieval, metadata management, courses assembling and all basic functionalities made available to the different users of the SILMS;
- To identify within the open source WEB repository the basic tools that are suitable to carry out the Learning Management System and the Social Networking System of the SILMS platform;
- To integrate these tools in our paradigm through a wise reconfiguration of specific modules and production of new ones; to describe our particular perspective from which we wish to develop the SILMS;
- To provide operational details on the current implementation of the system.
- To introduce the “Intelligent” components realized with a new Recommender System that will be better described in the chapter 7.

Besides introduction in Section 1 and conclusion in Section 5, the chapter is structured in 3 parts:

- Design of the SILMS, in Section 2
- Bottom-up functionalities developed in the SILMS , in Section 3
- Top-down functionalities developed in the SILMS, in Section 4

5.2 Design of the SILMS

Starting from the requirements outlined in the previous chapter, here we report the design of the SILMS that we are implementing.

In Section 5.2.1 we provide a general overview of the resources that are handled in the SILMS. We first start discussing the basic contents, the modules and the courses. Then, in Section 5.2.2 we describe the characteristics of metadata that can be associated with them, relying on the standard for Learning Object Metadata [4]. We remark that when contents, modules or courses are entered in the SILMS, metadata are associated with them and their persistence is bound to that of the resources that they describe. After discussing the users roles within the platform in Section 5.2.3, we discuss the life-cycle of these resources in Section 5.2.4. For each role, a list of functionalities that have been made available for them is described in Section 5.2.5 and the general architecture of the

SILMS is presented in Section 5.2.6. The support to multilingual and the social aspects to be included in the platform are discussed in Section 5.2.7 and 5.2.8, respectively. Finally, Section 5.2.9 deals with the characteristics of the recommendation system.

5.2.1 Resources to be handled: Contents, Modules and Courses

Contents can be PDFs, word documents, videos, images, text files, SCORM objects, links, and pretty much any type, so one of the things that have to be in the back of our mind when considering a repository is what it is for. Contents can be stored outside of the platform. However, references and metadata should be maintained in the platform.

A **module** is defined as a sequence of contents. Modules should be stored within our platform. A module is associated with metadata containing its description. Each module contains an arbitrary number of contents. We remark that the same content can be exploited in different modules and we wish to avoid the duplication of resources.

A **course** is defined as a sequence of modules. Also in this case, courses are stored within the SILMS. Each course contains an arbitrary number of modules. The same module can be used in different courses without duplication. Courses can either be developed by contributors through a manual composition of the available modules and contents, or under the guidance of a recommendation system that interactively helps the user in the identification of the modules and contents available in the system that match the contributor's preferences. The recommendation relies on: the metadata associated to contents and modules, the user profile, the expectation goals of the course to be developed, and user feedbacks on the contents and modules.

5.2.2 Metadata

Providing users with the ability to add descriptive words and phrases to a content is the starting point. These tags can be part of a structured and predefined list of classification tags such as a taxonomy or a user-defined-set of tags (social tagging) which is often called folksonomy. Moreover, a set of metadata should be associated with each content. Metadata can be extracted from the content itself, being specified either by the content owner when inserting the resource in the system, or completed by an expert during the phase of evaluation. We remark that the content can be either stored in the platform or maintained externally (in such a case we will have a link/pointer to the resource).

Special metadata that are considered are the SILMS Knowledge Areas introduced previous chapter. These areas represent the content type of the courses that can be offered. Namely, the SILMS Knowledge Areas are organized according to the following list:

- Entrepreneurial Vision
- Personal Development
- Communication Skills
- Economic Skills
- Technical Skills

Each knowledge area can be further refined in skills. Skills are thus a specialization of the knowledge area.

Each content/module can be associated with an arbitrary number of skills (eventually specified for different knowledge areas). By contrast, a course can be associated to a specific knowledge area (the main knowledge area) and to an arbitrary number of skills (eventually specified for different knowledge areas and automatically derived from the skills of the material contained in the course – either its files or its modules). Each course or module can be associated with two sets of skills: the prerequisite and the target skills. The prerequisite skills represent the knowledge that an user should hold in order to easily access to the information contained in the course/module. By contrast, the obtained skills represent the knowledge that the module/course will give to the attendee. This information can be exploited in the guided combination of modules in courses.

In order to determine the metadata to be considered in SILMS, it has been considered the IEEE standard LOM [4]. This standard provides a long list of metadata that can be categorized in: general, technical, educational and classification. These metadata can be associated to different resources starting from a specific content or an entire course. The standard is quite complex and articulated and we decided to consider a small subset of the possible metadata.

Table 8 reports the metadata that we consider for each content/module/course, its category and a brief description.

Table 8 Metadata description

Metadata	**category**	**Description**
Category	classification	knowledge area
Required Skills	classification	Skills needed to use the material (pre-requirements)
Acquired Skills	classification	Skills acquired after attending the module/course
Difficulty	educational	How hard it is to work with or through this resource for the typical intended target audience.
Format	technical	Technical data-type(s) of (all the components of) this resource
Keywords	general	Keywords

Language	general	Language of the resource
Learning-Resource-Type	educational	Specific kind of learning object (e.g. exercise, questionnaire, slide, module, course)
Typical Range Age	educational	Target audience
Typical Learning time	technical	Time requested for learning the resource

Metadata for modules can be (at least in part) automatically extracted from their contents. We remark that in this case, multiple values can be specified for the same properties (e.g. the language of the module is the union of the languages used in its contents). The specification of the metadata for courses follows a similar behavior.

5.2.3 Users

The system users are classified in terms of the kind of operations they are authorized to execute. Table 9 reports the kinds of user and a brief description of their role. They are presented at increased level of authorization, that means that each kind of users holds its permissions and those of the users described before him.

We remark that our portal is not directly conceived for students. The resources contained in the portal are devoted to teachers who need to learn different aspects of entrepreneurship or wish to produce a course for their students. Once the course has been set up, the course will be exported in an appropriate format and included in the LMS of the specific teacher. This does not prevent the possibility of exploiting the platform also for teaching the students. However, this possibility is marginal with respect to the current thesis work.

Table 9 NETT Users' Roles

Users	**Description**
Guest	This user can navigate on the portal without any authentication, however, s/he is not authorized to partecipate to the social activities of the system.
User	This user is authenticated within the portal. He can access to the contents and participate to the social activities of the system, but he cannot produce any new resources.

Contributor	This user is generally a teacher who can access to the resources to learn a new topic or produce new resources for his activity.
Expert	This user is authorized to evaluate new resources and to make it available to the community. The expert is generally an user or a contributor of the system who has gained the role of expert of a specific area.
Master	This role is attributed to a steering committee of the SILMS. A master holds administrative privileges for what concerns the editorial part of the SILMS. Therefore, a master is responsible to nominate (and revoke) experts, evaluate conflict of interests on the resources uploaded by teachers, remove resources or change the usage possibility to given users. In other words, he should be the manager of experts.
Administrator	This user has a general control on all the administration activities within the portal. He can change the role to the users (either add new privileges or remove old one), can access to statistics on the activities of the portal, remove or change contents, etc.

5.2.4 Life-cycle of a resource

In this section we describe the process of creation, verification, audit, publication and evaluation of a new resource (either content, module or course) that is created within the platform. These activities are realized from different user profiles of our system: contributor, expert and master.

The state-diagram proposed in Fig. 22 reports the different states in which a resource can lie and who can decide to move a resource into another state (with the corresponding motivation). The fact that a resource is in state “reject” does not mean that the resource is physically eliminated from the system. Indeed, in order to avoid the occurrence of dangling pointers, resources are not directly eliminated. However, when they are in the reject state, specific messages should be reported to the users and the resource is not accessible.

When a resource is in the state of verification, and an expert has accepted to review the resource, the expert and the contributor can discuss on the resource (their interaction can help to improve the resource). The passage from the audit state to the publication state can be automatic or not, depending on the level of experience of the expert.

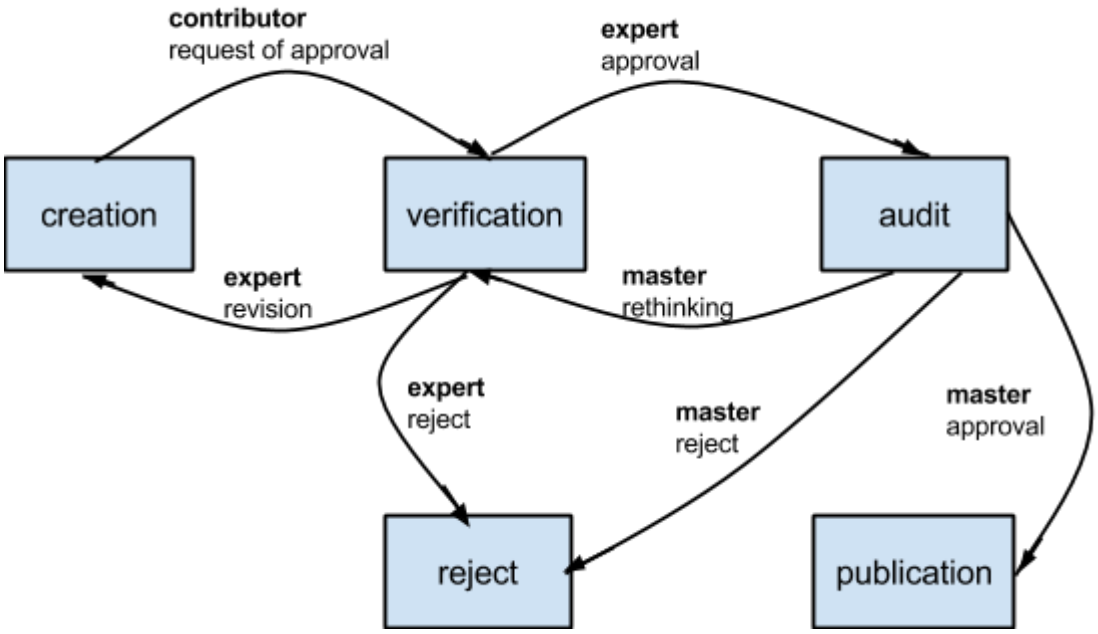


Figure 22 The life-cycle of a resource

The possibility to modify a resource is a key point to discuss. Indeed, in SILMS it has not been considered the possibility to maintain multiversions of the same resource. A resource can be updated at any time till the resource is published. Once the resource is published, it is not possible to modify it any longer. Whenever a contributor wishes to modify a resource already published, he/she has to generate a new resource with a new identifier.

Whenever a master decide to reject a resource already published, all the resources that have been realized as a follow-out of this resource are considered rejected. Since this operation might provoke a domino effect should be employed only when strictly needed.

5.2.5 SILMS Platform Functionalities

In the following tables we will provide the main functionalities of the SILMS for each kind of users. Since SILMS should stress the possibility to employ social network instruments, it has been pointed out the interactions that can occur within such functionality.

GUESTS/USERS

Functionality	Description	Interaction with
Parametric search	This functionality, customized for each kind of resources, allows the filtering of resources according to different metadata or the combination of different	

	parameters. Moreover, keyword-based retrieval should be possible.	
evaluation/ ILIKEIT	This functionality (only available for users) should be customized for contents, modules and courses. A user (not a guest) can express a vote on each resource. The vote should be a value between 0 to 5.	
tagging	This functionality (only available for users) should be customized for contents, modules and courses.	
participation to forum	This functionality (only available for users) should be customized for contents, modules and courses.	users, contributors, experts, master

CONTRIBUTORS

Functionality	**Description**	**Interaction with**
Insertion of a new content	This operation requires the insertion of the metadata associated with a content (we can explore the possibility to extract metadata directly from the resourse).	
Insertion of a new module	In addition to the metadata specified for the content, this operation requires to specify the macroarea, the title and the description of the module, and the contents that constitute the module. The content should be ordered by the author, in order to prescribe an order of access to the content resources. A parametric search interface should be offered to the contributor to select the resources to be included in the module (the presentation of the entire list of the contents is not adequate). Once the insertion of the resources is completed, this operation should try to automatically compute the metadata to be associated with the module by considering the metadata associated with the component resources. Missing information should be completed by the contributor.	

insertion of a new course	The behavior of this operation is similar to the previous one. In this case the building-blocks are not contents but modules. This operation results in the manual insertion of a course and does not exploit any intelligent support.	
Intelligent insertion of a new course	This functionality, by exploiting a recommendation system, should help a contributor in the specification of a new course	
Browse own resources	This functionality should be customized for contents, modules and courses. It should allow the contributor to see the resources (contents, modules and courses) that he/she has created and its status: 1. it is under verification; 2. it is publicly available; 3. it is no longer public (removed by the master).	
Status messages	This functionality is devoted to automatically informing the resource creators about the change of status of their resources. Moreover, this functionality should inform interested users when new resources have been introduced into the system.	
Submission of resources	Once a resource is completed, the contributor can submit the resource for evaluation to the experts. Once the resource has been submitted, it cannot be altered any longer until the expert has taken a decision.The contributor can, in any case, decide to withdraw the resource (in this case the entire revision process is stopped and eliminated).	
Revision of resources	When an expert has taken the decision of “revision” for a resource, contributor and expert should get in touch in order to discuss the modification to carry out on the resource	expert

EXPERTS

Functionality	**Description**	**Interaction with**

Evaluation	This functionality should be customized for contents, modules and courses. This functionality should allow the expert in the evaluation process. The following lists must be provided: - pending list of resources that: * require to be accepted for evaluation * are in the phase of revision * are completed but not yet processed by the Master * are accepted and made available to the community When clicking on a specific resource (either content, module or course) that platform should offer an adequate interface for the evaluation and for including comments. In the validation activity, the expert can get in touch with - other experts or the master - with the resource owner (contributor) The expert can add/remove/update metadata (specific metadata should be provided depending on the resource) The validation of a module depends on the validation of the contents that it contains. The validation of a course depends on the validation of the modules that contains. The outcome of this process can be: - reject - accept - still under revision - need revision In case of acceptance the expert can also give an evaluation of the quality of the developed resource. Whenever a resource is rejected it is kept available in the context of the contributor. The resource is removed from the Expert pending list.	experts, master contributor

Evaluation of module/course	In case of module/course, the expert should verify and check the metadata associated with the module/course	

MASTERS

Functionality	**Description**	**Interaction with**
Publishing	Relying on the evaluation performed by the expert, the master takes the responsibility to publish the resource. This activity could be automatic according to a gaming policy. The following lists should be provided: - list of resource that need to be published, - list of pending resources to be published (accepted to publication, but not completed), - list of resource already published. The master can also get in touch with other masters or experts before taking this decision. The outcome of this evaluation can be: - publish - revision - reject	masters, experts
Nominate experts	A master of the system can authorize users to become experts of the platform in a specific knowledge areas. A master can remove the privilege to any of the experts.	
Management of resources	Master has a plain control on all the resources that are handled by the system. For each kind of resource (content, module, course), the master holds the following lists: - List of published resources - List of resources under revision - List of resources that have been rejected	

	Whenever a resource is not adequate for the platform, the master can reject it.	
Expert Assignment	Upon the request of a resource to be published, the master should be equipped with an interface helping the identification of the available experts to be invited in the revision phase.	
Expert invitation	The master can get in touch with contributors, other masters, and people on the Web for inviting them to be part of the revision board.	

ADMINISTRATORS

Functionality	**Description**	**Interaction with**
Habilitation of users	Upon the request of an external user to become user of the SILMS, it provides an account into the system.	
Change role	It is in charge of changing the role of a user in contributor, expert or master (it can also downgrade a user from its role).	
Change visibility of resources	In any instant it can decide to change the visibility of any resource published in the platform.	
Statistics	Statistics on the access to the available resources, the resources created and accessed in a given period of time, the levels of satisfactions of users organized per course, per category and so on.	

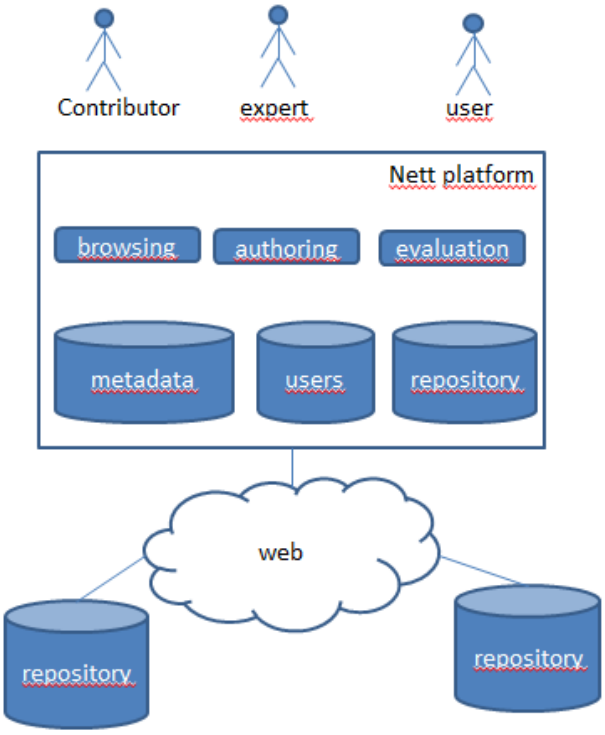


Figure 23 Architecture of the NETT platform

5.2.6 General architecture of the system

Figure 23 reports the general architecture of the SILMS. The picture points out that the contents handled by the system may be available outside of the SILMS. However, their metadata must be contained within the platform.

The SILMS must be equipped with all the functionalities described in the previous section. This requires the definition of proper interfaces for the navigation of the SILMS, for the authoring of new materials and for the evaluation and publication of materials. These interfaces are tailored on the role of the users that access the system.

We remark that the possibility to collect resources that are stored outside of the SILMS points out the need to guarantee the intellectual properties of their authors.

5.2.7 Multilingual Support

Tough English will be considered as lingua franca, the SILMS should be multilingual in all its parts:

- The general interface
- All the menus (included the skills' list)
- Metadata. They will be proposed to the users in their native/chosen language and stored in English within the system.

5.2.8 SILMS Social Aspects

One of the main objectives of the platform is to integrate in the management of courses the possibility for the SILMS users to collaborate and communicate by means of social networks functionalities. SILMS will be equipped with standard social network tools (like blogs, chat, forum, messaging, RFIDs). Moreover, the platform will be equipped with the following advanced functionalities specifically tailored for the SILMS :

- *Definition of community*. Around the main knowledge areas will be defined community of teachers. These communities will be moderated by the Knowledge areas' Master. The objective of these communities is to transform a personal learning experience in a more collaborative and amazing one, obtaining better results. Moreover, thematic communities can be freely created by teachers.
- *Sharing of didactical materials*. Beside the official version of didactic materials that is published by the SILMS platform, there will be the possibility to share non official didactic materials that solve the limit of experts' approval: in less time, a teacher can share didactic contents only with his/her contacts, without waiting experts' approval or masters' publication.
- *Informal communication among users*. While sharing, teachers will receive private or public feedbacks that can help him/her in improving his/her materials. Communications among contributors/experts and experts/masters can be conducted through social network facilities.
- *Teacher's Profile*. Teachers have to create and to edit their own profile, also with the possibility to share personal experience or school education, in order to help masters to decide who pass from teacher to contributor and to contributor to expert, basing only on competence and credits. They can also have the possibility to get in touch with other teachers beyond the SILMS, for example using Skype.
- *Followers*. Teachers can create a network composed by people with the same interests or experiences, and they can also follow a particular content or another user and consequently receive updates and news, keeping in touch with teachers with the same skills or of the same field.

Teachers can be considered on average experts in using technology, and they could need to manage a blog, to attach files to messages, to include images to posts and to configure comments that can be received on their blog.

5.2.9 Recommender System

A distinguishing approach in the SILMS is the use of learning algorithms to identify relations between the features of the platform contents that may prove suitable to the inquirer. Thanks to the massive use of metadata, the contents may be homogeneously identified through a vector of parameters (the metadata representation). In addition, thanks to the feedback of the previous users and the expertise of the system administrators, each composition of vectors in courses may be associated to a score. This enables a dynamical decision tree procedure where, depending on the current choice of the user, the system proposes branches of decision trees that may lead to

satisfactory completion of the course, possibly listed in a monotone ranking. The basic algorithm is C4.5 and variants [48]. At each step of the dynamics the task is to classify into merit classes the experimented suffixes of the growing courses putting in the highest levels of the three the vectors (contents) that are more discriminant in terms of entropic measures such as the information gain.

Indeed, given the classes $C_1,...,C_k$, and a set $S = s_1, s_2 ... s_n$ of already classified sampled data (the training set), each data s_i consisting of a p-dimensional vector $(x_1^i, x_2^i, ..., x_p^i)$ of features, at each node of the tree, C4.5 chooses the attribute of the data that most effectively splits the set of samples into subsets enriched in one class or another. A typical splitting criterion is the normalized information gain (difference in entropy). The attribute with the highest normalized information gain is chosen to make the decision. The recursion of this step leads either to subsets constituted of same class samples -- so that the classification is unambiguous, or sets with data with same features but different classes, which calls for fuzzy evaluations. The details of this algorithm are provided in Chapter 7.

Every user can rate materials and courses found in SILMS; the evaluations are stored in a table ad-hoc (created by SILMS Developers) and used to implement the Recommender System.

5.3 Bottom-up Functionalities implemented in the SILMS

This section starts with the description of the modifications that have been done on the Moodle platform in order to provide the functionalities presented in Section 1 that improve the State of Art described in Chapter 3. Specifically, we will present the functionalities that required a customization of Moodle parameters to create part of SILM.

We wish to remark that many efforts have been devoted to make the Moodle interface clean and simple in order to make the Web interfaces much usable and easy to use. However, we do not provide here a detailed description.

5.3.1 Management of Users Roles

Table 10 reports the user roles available in Moodle. They present some slight differences with the roles and privileges required in the SILMS. Therefore, starting from Moodle standard roles and their privileges, new roles have been created:

Table 10 Moodle Users Roles

Role	Description
Site administrator	Site administrators have permissions to do anything.
Manager	An administrator role with lesser privileges that enables the holders for accessing courses and modifying them.

Course creator	A user with this role can create a course. The role of course creator is typically assigned to a master teacher, department head or program coordinator.
Teacher	Teachers can manage and add content to courses: Teachers can do anything within a course, including changing the activities and grading students.
Non-editing teacher	A non-editing teacher is able within a course to view and grade students' work but may not alter or delete any of the activities or resources.
Student	Student can access and participate in courses.
Guest	Guest can view courses but not participate: In addition, logged-in users can enter any courses that allow guest access without the need to enrol. Guests always have "read-only" access. I.e they can't leave any posts or otherwise mess up the course for real students.
Authenticated user	The that role all logged in users have.

Table 11 reports how the SILMS users roles that have been described in Section 5.2.2 of the current chapter have been implemented in Moodle. Specifically, the table reports the Moodle user roles adopted, the contexts in which the role can be used, the granted and withdrawn privileges specified for the SILMS role.

Table 11 SILMS Users roles

SILMS User Role	Based on Moodle role	Usable contexts	Granted Privileges	Withdrawn Privileges
Guest	Guest	the same as	None	none
User	User	the same as	“create course”	none
Contributor	Editing teacher	course, activity module.	none	“control section visibility”, “assign roles to users”, “modify privileges to other users”, “modify secure authorization to other users”, “use other roles”, “access all groups”

Expert	Manager	category, course, activity module	None	“assign role to users”, “modify privileges to other users”, “modify secure authorization to other users”, “use other roles”, “manage categories”, “access all groups”
Master	Manager	category, course, activity module	None	none
Administrator	administrator	the same	None	none

We need to remark that Expert should have the grant to change the role to users and contributors into the one of experts. Moreover, whenever a user creates a course, this is only available for himself. The course becomes public only when the Master decides to make it visible to the entire community.

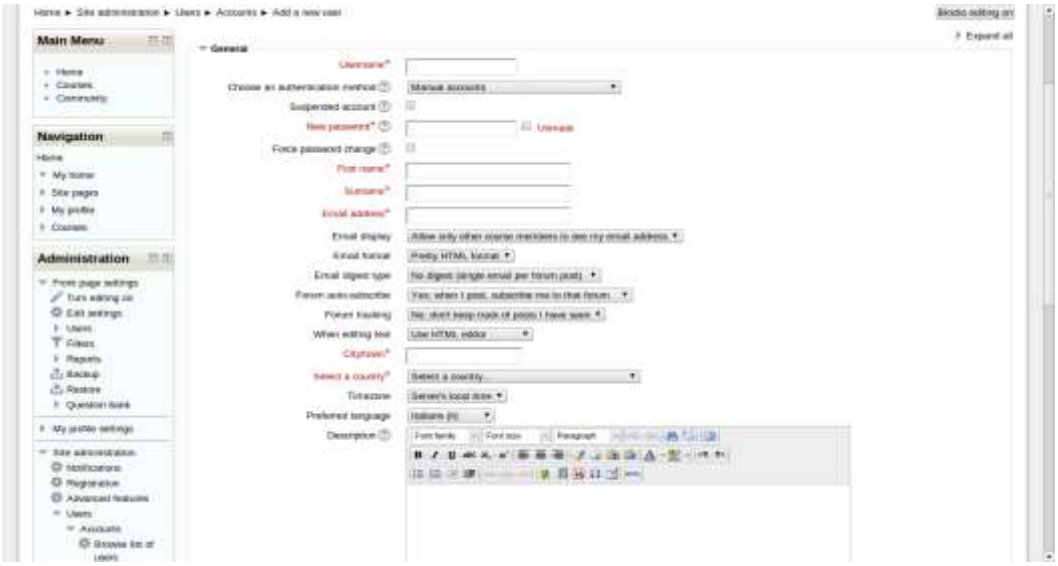


Figure 24 Administrator Interface for the creation of a new user

Fig. 24 shows the web page available for the Administrator for the creation of a user (the default role is user). Then, by means of the web page in Figure 25 it is possible to nominate a user the master of a given knowledge area. Note that when a user becomes

an expert or a master, it is required to specify the knowledge area. Figure 26 shows the web page available for the Master for assigning the role of Expert to a contributor.

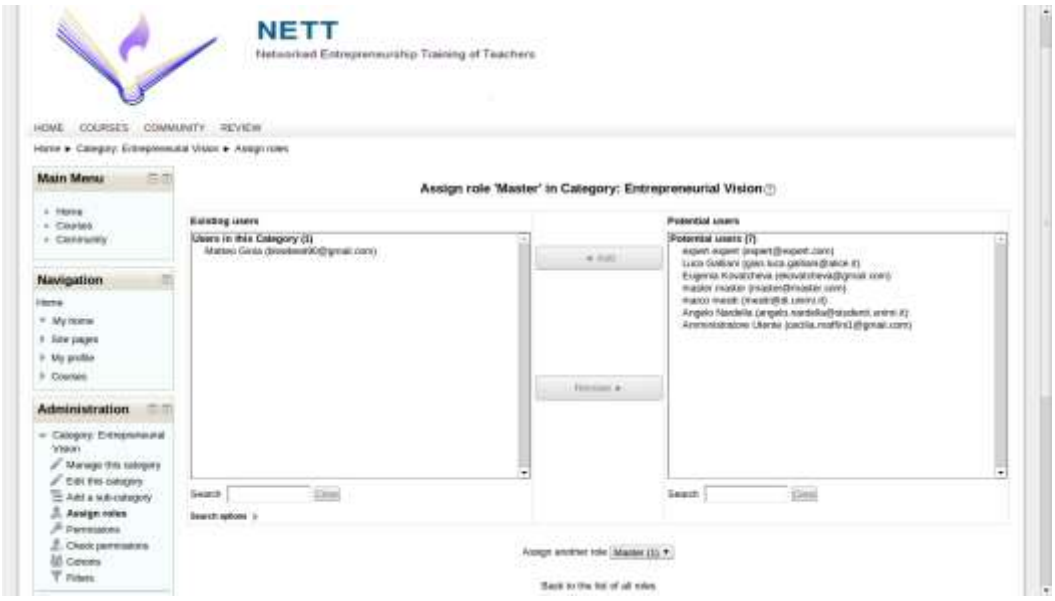


Figure 25 Interface for the nomination of Masters

Figure 26 Interface for the assignment of the roles of expert to a users

5.3.2 Modules Life Cycle

Whenever a Contributor creates a new module for a course, the module should be subjected to a process of validation as described in Figure 22. In this section we describe its implementation in the context of Moodle.

Figure 27 shows the web page for the creation of a module, named M. Its author, named C, should have the role of contributor and the module should be bound to a give knowledge area K. At this point the contributor can ask that the module can be made available to the entire community.

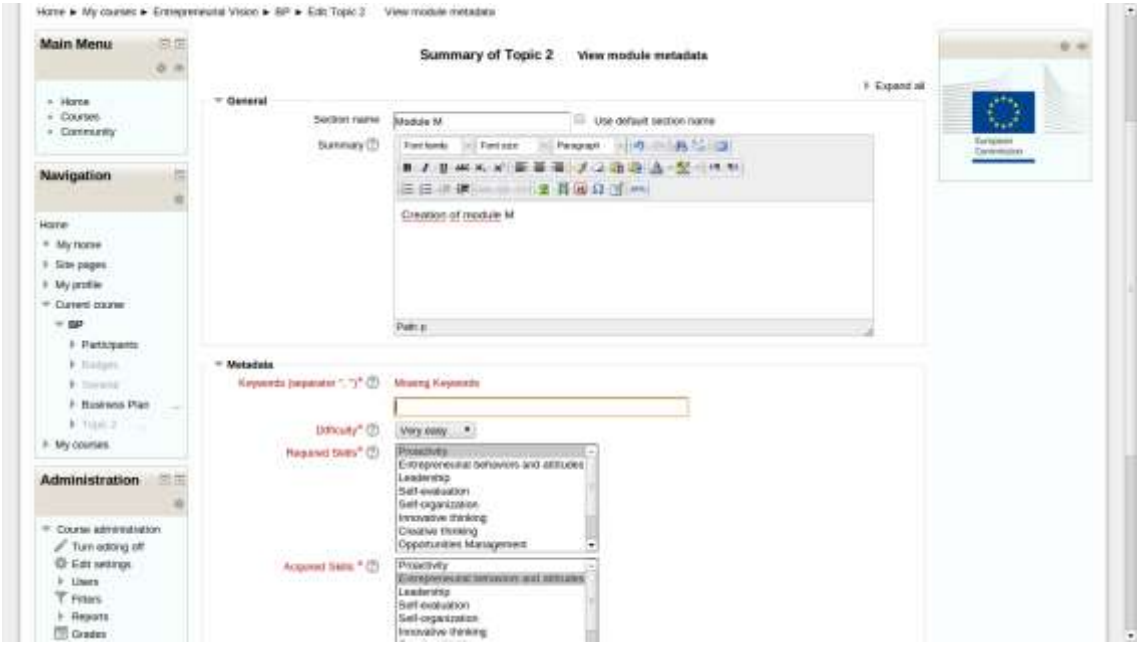


Figure 27 Interface for the creation of a module

The master, named MR, associated with the knowledge area K, will receive a request of approval of the module M from the contributor C. Figure 28 shows the web page available to the master to handle the assignment of modules to reviewers. This interface is really useful to the Master to keep track of the status of the modules under its responsibility. Indeed, the interface shows the pending lists of modules that need to be assigned for revision, those that are under revision, and those that completed the revision phase and only wait for its decision, and, finally, those for which a decision (either reject, accepted or published) has been taken.

Figure 28 Assignment of a module to reviewers

The Expert E, nominated by the Master MR, receives a request of revision by MR and should accept the invitation to make a review. Once, accepted the invitation, the Expert environment is equipped with a web page like the one in Figure 29 containing the pending list of the modules under revision and a web page for the evaluation of a module and for assessing an evaluation to the module (either accept, rejected, or requiring revision). The expert can also get in touch with the contributor by means of the social network facilities developed for SILMS.

The assignment of a module to a reviewer requires storing this information into a database table. The characteristics of this table will be described in Section 5.4.1.

Figure 29 Acceptance or Rejection of a Module

5.3.3 Social functionalities made available by Moodle

Table 12 reports the plugins available in Moodle to improve the social collaboration among Moodle users. We remark that some of the functionalities are specifically tailored to create a communication between the course teacher and his students. In the current implementation we made available such functionalities also for the SILMS users.

Table 12 Moodle functionalities for improving the social collaboration of users

Functionality	Description
Blogs	Blogs are a form of online journal used by millions of people for self-expression and communicating with family and friends. Blogs in Moodle are user based - each user has their own blog.
Comments	Comments can be added to any page in Moodle
Tags	Tags allow students and teachers to describe their interests. Tags are included in the user's profile
Messaging	"Messaging" refers both to automatic alerts from Moodle about new forum posts, assignment submission notifications, etc., and also to conversations using the instant messaging feature
Message alerts	They can be triggered in the following cases: users receive instant messages; students are messaged by their course tutor; teachers/admins receive automatic notifications of assignment submissions/site problems
Notes	Notes are information about a user attached by another user
RSS feeds	RSS (really simple syndication) feeds in Moodle enable people to stay up to date with forum posts, glossary entries and other events within Moodle.

5.4 Top-down Functionalities implemented in the SILMS

In the previous section we discussed the modification of the Moodle platform that required a customization of its functionalities. In this chapter, by contrast, we describe the functionalities that required to develop PHP modules and to modify the Moodle internal database.

5.4.1 Extension to the Moodle Database

In order to provide the functionalities described in Section 5.2, the Moodle database has been enhanced with a few tables.

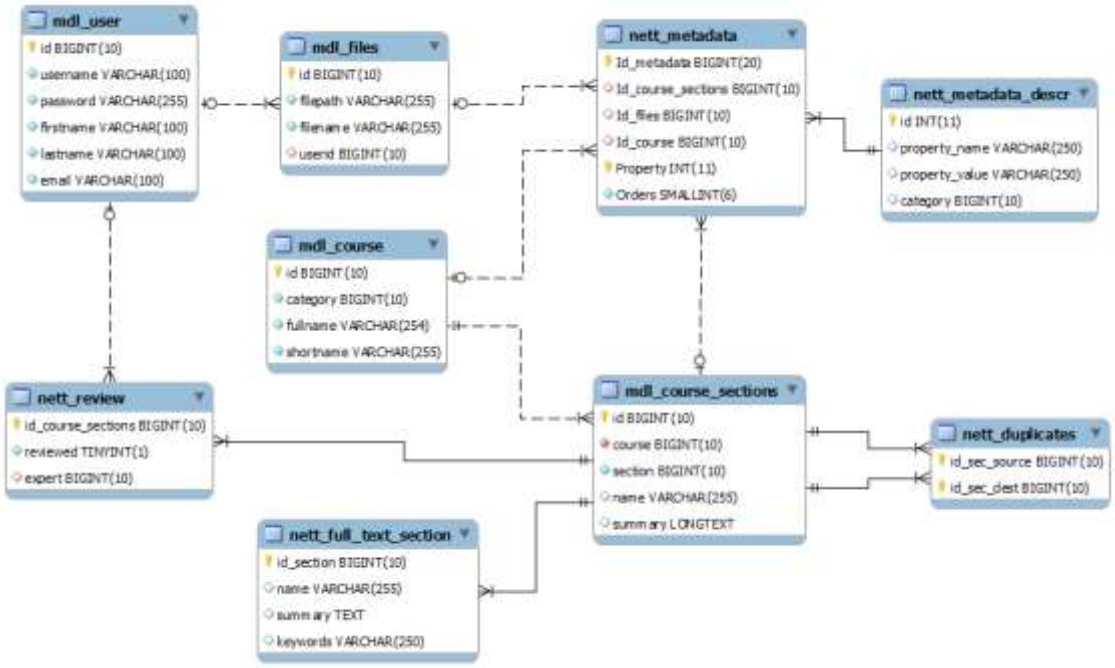


Figure 30 "NETT"-tables inserted in the MOODLE database

Figure 30 reports the tables added to the Moodle database (the new tables are named nett_"name of the table",). As for the standard table, we remark that we have reported a subset of attributes for the sake of readability. In the remainder we describe each new introduced table. We need also to remark that the concept of "module", which we have described in Section 5.2, corresponds to the concept of "section" in Moodle. Therefore, the Moodle table containing the modules associated with a course is named mdl_course_sections. Table nett_metadata_descr contains the possible values for the metadata reported in Table 8 of Section 5.2.2.

When the property_name attribute contains a skill (either acquired or derived), the category attribute contains the corresponding category. This table does not contain values for keywords because they can assume any value.

Table nett_metadata contains the metadata that have been specified for a course, a module, or a single file. Since the same property can assume different values (e.g. the language for a course can be English or Italian), the order attribute is used to represent the list of different values.

Table nett_duplicates reports the modules that are identical. This situation can happen when a Teacher searches for a given module already developed by other contributors and includes it in his course "as it is". This table takes track of the fact they are identical and when a user is looking for modules a single copy of the module is returned .

Table nett_revision denotes the Expert that is reviewing a given section. The reviewed attribute can assume the value 0 (under revision), or 1 (revision completed).

Table nett_full_text_section contains some columns of the modules for handling full text search (details in Section 5.2.2)

5.4.2 Metadata Management

In the previous section we discussed how metadata are stored within the SILMS , while this section explains how metadata are assigned to resources (contents, modules or courses). We remark that contents are contained in modules and modules are contained in courses; therefore a nesting hierarchy can be established among resources. We need to point out the presence of three kinds of metadata:

- Metadata that are specified for a single resource (e.g. keywords);
- Metadata that are specified for a resource and need to be propagated to the higher levels of the nesting hierarchy (e.g. the language specified for a file -content- can be propagated to the module and the course containing the file)
- Metadata that are specified for a resource and need to be propagated to the lower levels of the nesting hierarchy (e.g. typical range age specified for the course should be propagated to its modules and in turns to the files contained in the modules).

There are also metadata that Moodle directly extracts from contents and that can be reported in the nett_metadata table avoiding to ask the user to re-digit the same information.

Table 13 specifies for each metadata its meaning and whether it is specified on a given resource ("specified"), extracted from the content ("extracted") or automatically propagated ("AP") to the containing/container resources. The table also reports whether the metadata is single value ("SV") or multi value ("MV"). When "MV" is combined with automatically propagated "AP", it means that the values are the union of the values of the containing/container resources.

Table 13 Metadata specification and propagation

Metadata	**Meaning**	**Content**	**Module**	**Course**
Language	Language of the content	Specified (SV)	AP (MV)	AP (MV)
Keywords	Keywords related to the content	Specified (MV)	Specified (MV)	Specified (MV)
Format	Data type of all the	Extracted (SV)	AP (MV)	AP (MV)

	components of a LO			
Requirements	Skill needed to use materials	--	Specified (MV)	AP (MV)
Learning ResourceType	LO type	Extracted (SV)	AP (MV)	AP (MV)
TypicalRangeAge	Range Age	--	AP (MV)	Specified (MV)
Difficulty	Difficulty feeling by the content user	--	Specified (SV)	--
TypicalLearningTime	Typical Learning Time	Specified (SV)	AP (SV)	AP (SV)
Output	Skills obtained after using content	--	Specified (MV)	AP (MV)
Taxon	Knowledge area obtained after using content	--	Specified (MV)	AP (MV)

5.4.3 Course Creation

Moodle offers a teacher the possibility of creating a course. However, the modules and contents specified within the course are local to the course itself and there are no facilities for the reuse of the material already included in the platform. In the SILMS the web page for the creation of a course has been enhanced:

- to specify metadata at course, module and content level;
- to add modules (developed by other contributors) to the course by exploiting an intelligent retrieval system.

We remark that in the technical specification of the system we have planned to make any kind of resource to be exportable. However, in the current implementation we have focused only on modules. We wish to evaluate the utility of this feature with teachers before moving to the implementation of the exporting of entire courses or single files.

The possibility to include in a course modules developed by other authors can lead to the duplication of the module multiple times. This can have negative effects in the intelligent retrieval system, since the same module is presented many times. For this reason there is the need to take duplications under control.

In the remainder of the section we describe the interfaces for the specification of metadata. Then, we describe our intelligent retrieval system. We conclude the section with a description of the duplicates' management.

5.4.4 Interfaces for the Metadata Specification

In order to have courses, modules and contents to be used properly by teachers, their colleagues, and other researchers in the future, metadata information must to be properly inserted and stored. Metadata management enables us understanding data in detail and will enable other users to find and properly re-use modules created by teachers using the SILMS .

Metadata are inserted when courses and modules are created or their content imported.

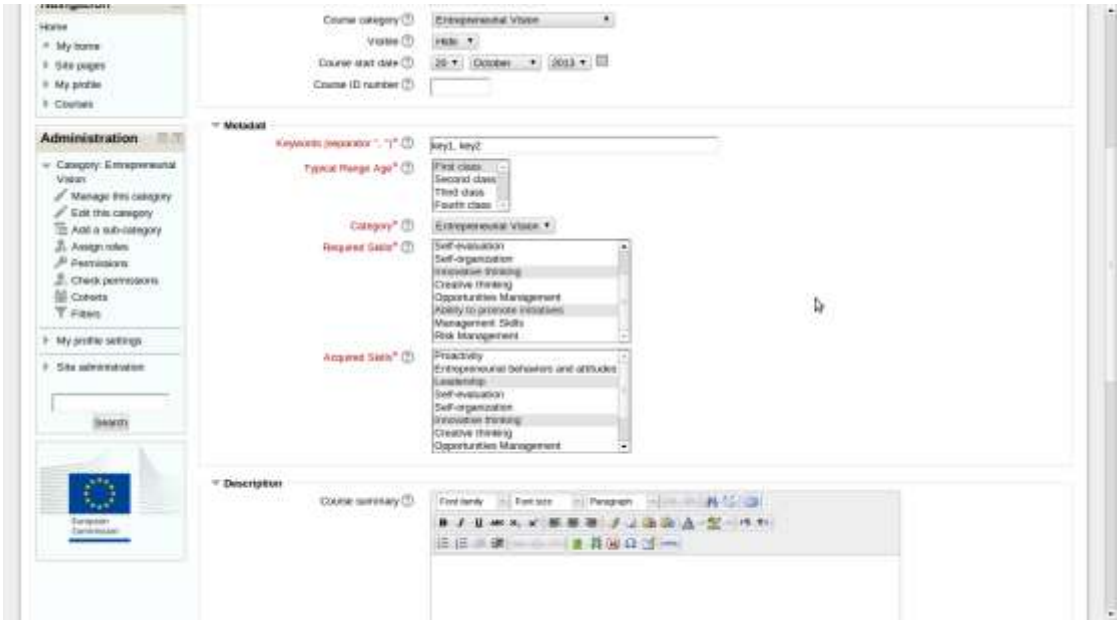


Figure 31 Interface used to insert metadata of a course

Figure 31 presents the web interface devoted to insert information about a new course. At this stage the user has to define the following set of metadata: *Keywords, TypicalRangeAge, Category, required skills* and *acquired skills*.

After that a new course has been instantiated (created) the user can create new modules. In Figure 32 a screenshot explains the metadata information needed to be inserted at this stage. The metadata are: *Keywords, Difficulty, required skills,* and *acquired skills.*

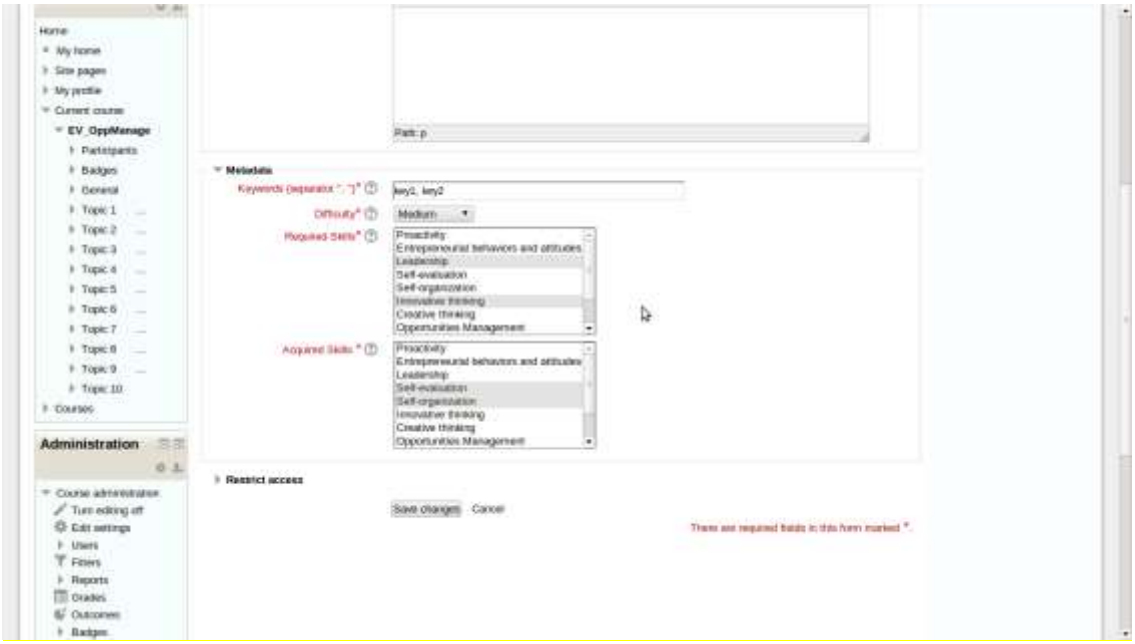


Figure 32 Interface used to insert metadata of a module

Once the metadata have been inserted, a propagation procedure triggers for copying metadata from the module towards the course and vice versa. The propagation is useful for better describing the new module by using the metadata associated to the course and for better characterizing the course exploiting the module's metadata. The metadata copied from the course to the module are: *TypicalRangeAge* and *Category*. Whereas, the metadata: *required skills* and *acquired skills* are propagated from the module to the course. In this way the prerequisite skills of a course, and the skills earned during the course fruition are enriched using the skills specified at module level.

Finally, Figure 33 presents the web interface devoted to insert information about a new content imported in a module. At this stage the user has to define the following set of metadata: *Language, Keywords, format, LearningResourceType, TypicalLearningTime.*

As during the module creation also at this stage a propagation procedure is used to copy content metadata towards the module and the course.

At the end of the creation of new course or module, or the importing of contents, a metadata table is populated in the Moodle database for the purpose of searching and providing structured or semi-structured information about the didactic material.

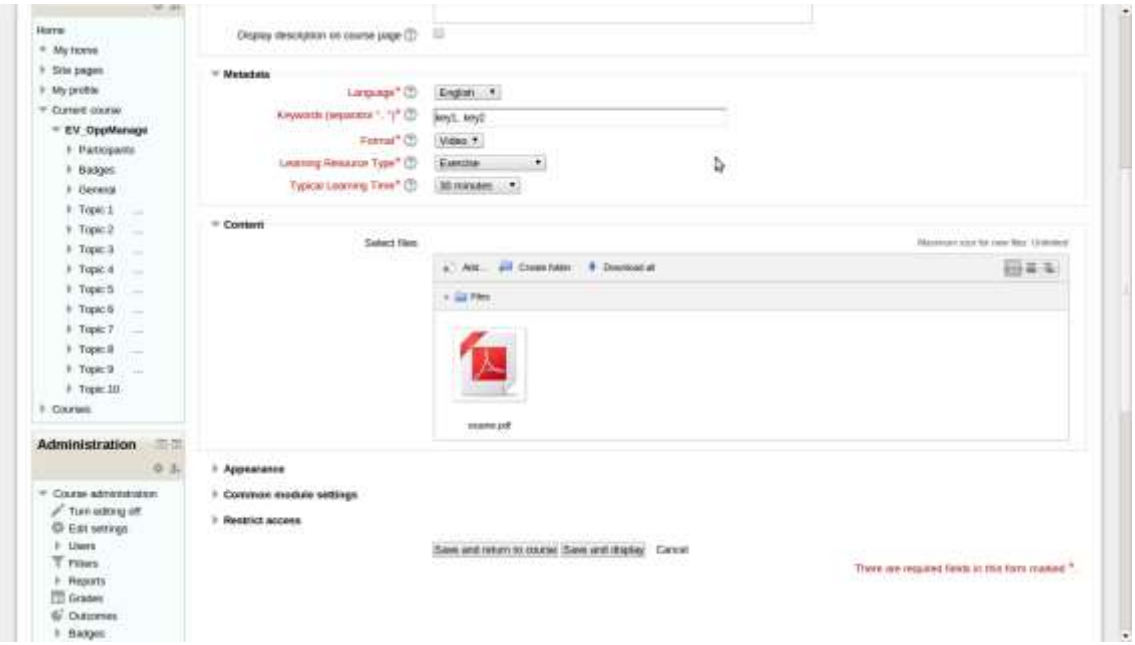


Figure 33 Interface used to insert metadata of a content

5.4.5 Intelligent Retrieval of Modules

In our system each course, module or content is associated to metadata that describe the didactic material and gives meaning to it.

This set of metadata is primarily used for searching. By exploiting these metadata, it's possible to construct a search engine able to offer teachers the possibility to discover modules to insert as part of the course that she/he is creating.

In Figure 34 a teacher is using the search module (part A of the figure) for discovering modules that she/he could insert in her/his course (part B of the figure). The standard search method for looking for modules involves searching against metadata attached to the course that the teacher is creating. In figure the metadata are already set, by using metadata associate to the course. In this way, in the first box of the part B of the figure, a list of modules compatible with the selected metadata (the metadata imported by the course) is visualized.

Then the teacher can shift the wished modules in the second box and submit the request.

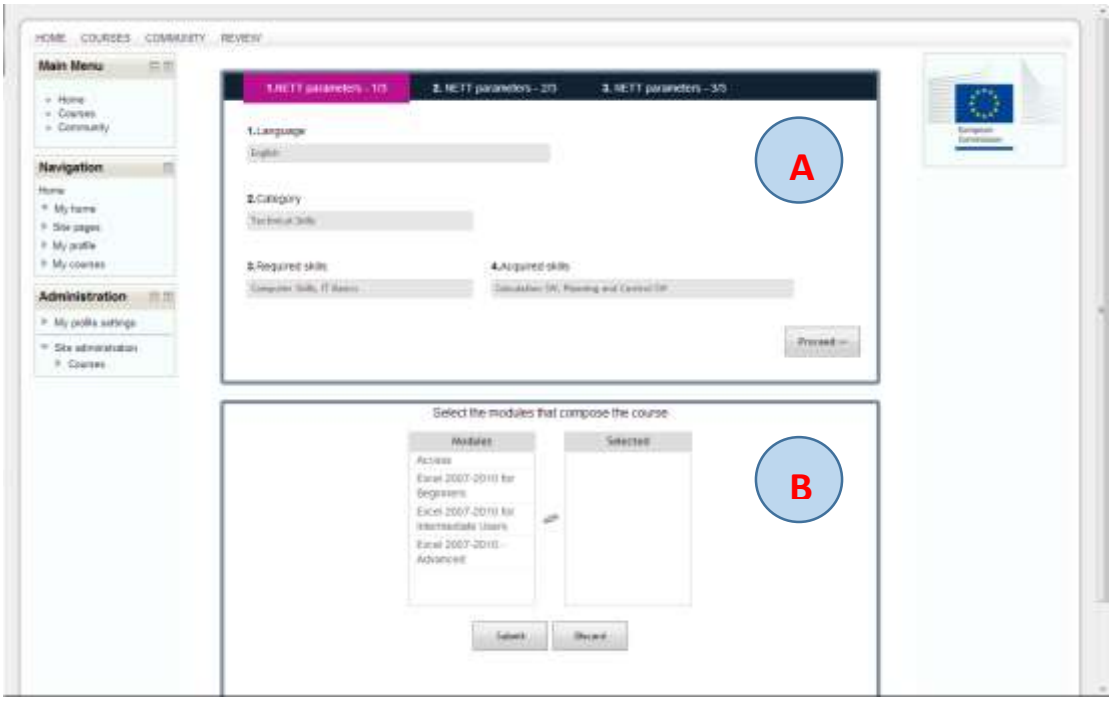


Figure 34 Search engine used by the user to find modules to insert in her/his course. In the part A the user can set metadata in part B a list of modules complying to the selected metadata is visualized

The search engine can make use of the individual metadata fields to perform searches not necessarily associated with the metadata imported by the course. To do it the teacher can deselect the preset metadata fields and/or she/he can set other filters using the interface

Using this search engine, the user can also do an advanced query using the keywords fields (see Figure 35). Using metadata to describe modules is a great way to help people to navigate and find modules. At some point, however, someone will want to find all the modules that pertain to a certain topic that may not have a proper metadata of its own, or may span many metadata. This is what this part of the search engine is for.

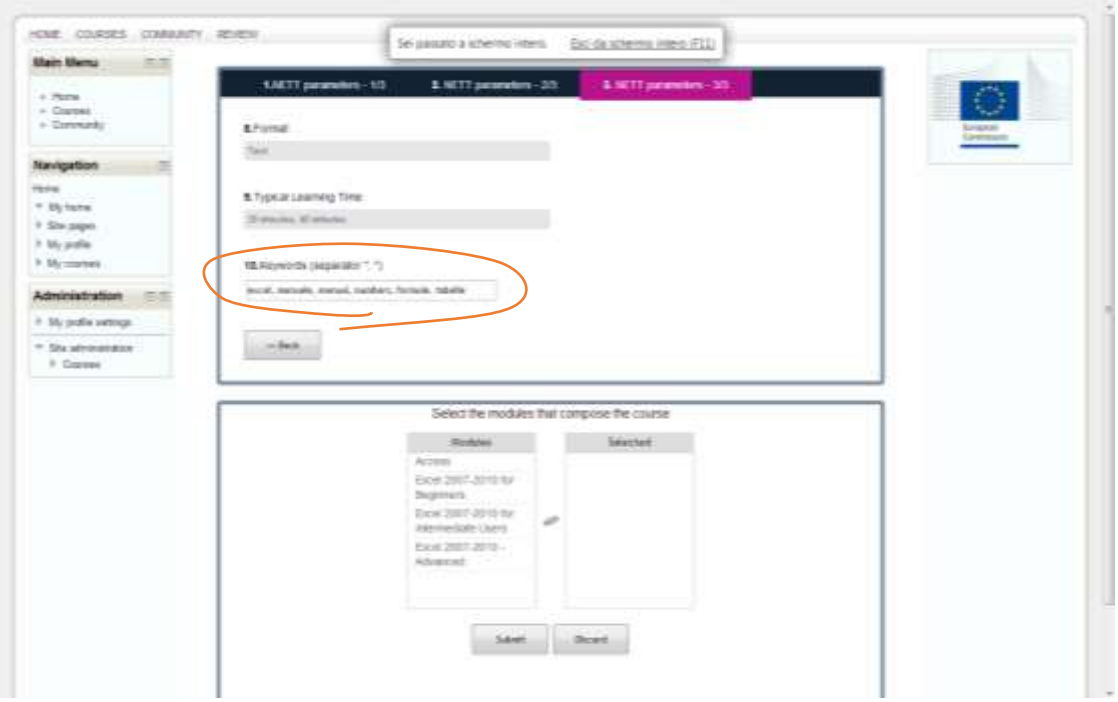


Figure 35 The keywords field of the search form. Using this field the user can trigger a full-text search based on the title, the summary and the keywords associated to the modules

To improve the search engine a full-text functionality has been integrated. The full-text search is enabled on the field title, summary and keywords associated with a module. With a full-text search we have several advantages: First, it is better in terms of performance (faster researches), then the search allows a precise ordering of the results based on the level of relevance to the researched modules. Said in other words, the search engine weighs the results

MySQL (the DBMS at the base of Moodle) provides a research methodology that allows us to get FULL TEXT results chosen on the basis of the relevance between the search key and content. Exploiting this functionality the user can write in the keywords field of the search form the terms that will be searched in the title, in the summary and in keywords associated with all modules contained in the repository.

Another functionality has been implemented for supporting further fine-grained searches. It tells the search engine to look for words that have a similar structure to the word being searched on. So a search on the word “table”, might also look for “tables”. Moreover, by linking this stem search to a thesaurus, the engine can perform intelligent queries using the thesaurus as a base. So a search on “excel” linked to a thesaurus, might also search on “spreadsheet” in the title, summary or keywords of a module. A thesaurus can be described as a set of terms linked together based on similarity. The terms belong to a controlled vocabulary. This is important, as new thesaurus terms cannot be added without clarification by an authority, in our case expert of entrepreneurship area. By using a thesaurus, the search engine can intelligently broaden the width of the search, allowing more results to be returned.

5.4.6 Management of Modules Duplications

Duplications are handled through the Duplicates(source,destination). Each time a module *s* is duplicated, a tuple is inserted in this table through the following algorithm:

- If s has never been duplicated (i.e. Table Duplicates does not contain a tuple in which s is the destination)
- then the tuple (s,d) in inserted in the table Duplicates, where d id the identifier of the module duplicated.
- else (table Duplicates contains a tuple (s',s)), the tuple (s',d) is inserted in the table Duplicates.
- This algorithm guarantees that each duplication is always associated with the original module (i.e. the first module starting from which duplications have been realized). This means that if s3 is the duplication of s2 and s2 is the duplication of s1 which is in turn the duplication of s0, Table Duplicates contains the tuples (s0,s1), (s0,s2), (s0,s3).

Whenever a Contributor imports a module in his course and applies a modification to the imported module, the corresponding tuple in Table Duplicates is removed. A module is considered "modified" in the following cases:

- Whenever a file contained in the module is modified or removed or a new file is introduced in the module
- Whenever the properties of the module (included the metadata) are modified.

Table Duplicates is used in the intelligent retrieval system in the following way. A module that meets the retrieval parameters is returned if its identifier is not contained in the destination attribute of the Table Duplicates.

5.4.7 Management of Social Aspects with Mahara

As described in chapter 3 " State of the Art" , Mahara supports social networking and online community through the groups and friends features – an ePortfolio environment that we could use for a group of teachers who wanted to create an electronic version of their paper/printed portfolio/assessment document that they have typically completed each year or during his or her own career. The goal is to create a space where faculty can share their portfolio and interact with peer portfolios with the goal of creating some additional interdisciplinary/inter-grade level interaction.

One of the features activated during the integration is the ability to import threads, comments and news from Moodle on the Mahara's profile by clicking on a link that appears at the bottom right in the box form "Export to a portfolio".

On logging on to the homepage of Mahara, in addition to displaying some information about the user profile, there are three windows for the customization of the account (see Figure 36). Share and network is one that, if checked, allows us to edit preferences for groups, friends and privacy settings of our profile.

Figure 36 Functionalities available in Mahara

Clicking on our name in the top right on the homepage gives access to the personal page (Figure 37). Our profile page is customizable (by clicking on "edit this page" at the top left corner) by adding or removing various "blocks" as "wall", "about me" ... etc. In Mahara they are called Blocktypes. In a view, a blocktype is one of the blocks that sits in the tabbed panel at the top of the page and can be dragged on to a view. Example blocktypes include "Blog Post", "Profile Information" and "Text Box". Note that this is different from the various sideblocks that are displayed throughout the site. Some blocktypes, such as blog post, are tied to artifacts. Some, like profile information, are tied to more than one artifact, and others, like text box, are not related to artifacts. When blocktypes are dragged on to a view, they create a "block instance". Block instances are to block types what objects are to classes in Object Oriented programming. A view can have many different block instances of many different block types - for example, you could add the blog post blocktype to a view twice and have each one show a different blog post.

Integration through Mahara and Moodle might be improved by writing custom blocktypes for displaying information related to your Moodle profile.

Figure 37 Mahara Personal Home Page

Design and development components SILMS Social Netwotk

The main objectives of the components designed and developed in Mahara are:

- Increasing the integration between the two web application
    - configuration of a single sign-on
    - development of custom BlockType
    - writing special trigger
    - writing functions for creating an auto-enrollment to user groups according to the role of the area
- Allowing the movement of Learning Object in SILMS Social Network
    - creation of a new type of view "module"
    - development of functions for the automatic import of learning objects
    - rating system for the modules

SSO (integration single sign on)

Since the platform integrates two different web applications (Moodle and Mahara), the needarises to make more easy access for the use of the system. We hit this goal through the function SingleSignOn (or SSO).

Thanks to SSO a user authenticates to a web application, through a simple click on a special link can authenticate on another. This feature is intended to operate on a machine completely different.

The use of single sign-on system improves considerably the user experience, because the user does not have to:

- create a second account
- find a new username
- remember two passwords
- remember two URLs
- authenticate another application
- create two profiles

Since the release of Mahara 0.8.1 and Moodle 1.9, we can configure both platforms so as to allow the authentication via SSO in both directions using an encryption public key.

Development of custom Block Types

In order to increase the integration between LMS and Social Network, a specific BlockType was developed to allow users who visit our profile on SILMS Social Network to display modules published in courses with our profile, named "my modules" .

Figure 38 "MyModules" blocktype

Below a series of modules defined or extended during development:

- **Function single_only()**: Returns True or False. If it returns True, it means that the user can use only one instance of this BlockType in a particular view of Mahara;

- **Function get_title()**: Returns the title of BlockType plugin, as defined in the language file blocktype.mymodules.php. It returns BlockType title in the language in which Mahara is set, or in English if the translation was nonexistent;

- **Function get_description()**: Returns the description BlockType plugin, as defined in the language file blocktype.mymodules.php. Returns the description of BlockType in the language in which Mahara is set, or in English if the translation was nonexistent;

- **Function get_categories()**: Returns the category in which the BlockType plugin appears. Possible values are: blogs, feeds, file, image, video, general, internal and resume. These Mahara categories are defined in the database, via the table blocktype_category. In our case it was entered in the category general;

- **Function has_instance_config()**: Returns True or False. If it returns True it means that the plugin has a form of BlockType initial configuration in which the user provides additional data, parameters, etc. that will influence the display of BlockType in view of Mahara;

- **Function default_copy_type()**: Returns what must be copied when you export the BlockType format LEAP2A;

To make BlockType "MyModules" a building block of dashboard, a series of triggers have been developed in the database.

Pages in Mahara

The Mahara atomica parts are the "views" or pages, which by default are divided in 4 categories in the system:

- **dashboard**: not visible to other users, it is its customizable Mahara page (the equivalent of our wall in facebook).

- **profile**: It is the page containing our profile, to which users can be accessed by clicking on the name of any user. Like the above page, it is customizable at will, through the inclusion of an arbitrary number of instances of blocktypes.

- **group homepage**: type of page that constitutes the homepage of each Group created within SILMS Sociail Network. Any user can create and manage groups within the platform. Access is restricted to specific subsets of users or invitations.

- **view (generic)**: generic page that can be created and edited freely by any user.

These types of view are present by default in Mahara. However, the management of its modules is inadequate. Hence, it was decided to implement, at level of Database, a new type of page with which we could publish and share our modules:

- **module**: The creation of a new page type allows us to manage the pages of type "module" differently from all the others.
  For example, by entering the table "Blocktype_installed_viewtype" of Mahara we can define which BlockType are insertable in this particular type of page, and hide to the users all blocks that are not necessary in a page "Module", and we simultaneously make usable only those blocks that have changed or written specifically for the view type "module"

Automatic creation groups

The tendency of people to come together and form groups is inherent in the structure of the society and the way they take shape and evolve over time is a theme that recurs in social science research.

The group homepage is the central space for a group, where the users can view contents, forums and discussions.

In particular, Moodle courses are divided into five main categories and users in three different roles.

It was then designed and developed a routine for the automatic creation of corresponding groups, where the teachers belonging to a same knowledge area or

having the same role in the review process (Contributor, Experts, Masters) were grouped.

The groups to which each user is registered are visible and navigable in the box positioned at the top left in his own dashboard.

Each group home page can be customized by inserting blocks by the administrator, who can activate the changes selecting "edit" in the upper left.

Figure 39 Mahara 'Group' BlockType

5.5 Conclusions and Future steps

This document describes the current release of the SILMS , in terms of both integration of Moodle and Mahara modules into the widest framework of the SILMS for the case study NETT project and operational details to implement its functionalities on the part of either users or administrators.

Though the integration required the production of new modules, besides a heavy reworking of many ones provided by Moodle, some more modules will be generated by the next release in order to fully implement relevant functionalities as the recommender system better described in the next chapter.

6. SILMS TESTING RESULTS

6.1 Summary

This chapter describes the test campaign of the usability analysis carried out during the development of the SILMS. The goals of usability testing include establishing a baseline of user performance, establishing and validating user performance measures, and identifying potential design concerns to be addressed in order to improve the efficiency, productivity, and end-user satisfaction.

The usability test objectives are:

- To determine design inconsistencies and usability problem areas within the user interface and content areas. Potential sources of problems may include:
  - *Navigation problems*: failure to locate functions, excessive keystrokes to complete a function, failure to follow recommended screen flow.
  - *Presentation problems*: failure to locate and properly act upon desired information in screens, selection errors due to labelling ambiguities.
  - *Control usage problems*: improper toolbar or entry field usage.
- To exercise the application under controlled test conditions with representative users. Data are used to assess whether usability goals regarding an effective, efficient, and well-received user interface have been achieved.
- To establish baseline user-performance and user-satisfaction levels of the user interface for future improvements and usability evaluations.

The system is tailored to give teachers and trainers appropriate knowledge, skills, and innovative tools in the domain of the entrepreneurial education. To this end, the system is endowed with a social network where teachers can formally or informally share experiences supporting their peers with technical training, along with theory and practical examples deriving from mutual and practical experiences in entrepreneurship.

The goal of the platform is thus to support teachers in the formulation of courses in this discipline and create a Social Community where people involved in entrepreneurship education will debate on specific topics and find concrete helps for realizing an European way of training young people to become entrepreneurs, yet in respect of local industrial and commercial frameworks. Extra services, named meta-services, are integrated in the platform to satisfy the teachers' needs who are demanding users of the platform, that is individuals that are accustomed to produce educational materials and have clear ideas on the topics to be taught according to the level of preparation of the class to which they are intended.

The high-level summary of findings includes:

- Overall task performance
- User difficulties and frustrations with the site
- Significant usability results (may include positive as well as negative results)

The chapter is structured in four sections: Section 2 deals with the testing strategy, Section 3 with the corresponding methodology, Section 4 with its implementation and Section 5 with the experimental results. Conclusions and appendices are reported in further sections

6.2 Strategy

The SILMS aims at proposing a solution based on a social oriented strategy where the educational learning process is created and shared from down top by a community of teachers. Specifically, the goal of the site is to provide:

- Credible, trustworthy, reliable, research-based and peer-reviewed content.
- Timely, current and well-timed content, resources, and knowledge.
- Evergreen reference material that remains applicable over time.

Usability testing is a method to evaluate a product. In its current state the platform extracts learning contents from an internal repository according to the user needs and specific quality criteria. The standard operational scenario is represented by a teacher who decides to create a new course and wishes to draw the related didactical material. The information he's expecting drawing from the platform is twofold: 1) how to optimally organize the course as for its layout and employed media, and 2) teaching material to fill up into the layout in either their original issue or modified by the teacher himself. To achieve the goal the following services are assessed:

1. Creating teaching courses. The prototype enables teachers to create, delete or modify courses. Specifically it supports them in combining resources in modules for integrating them in new courses.
2. Tagging of the contents with LOM metadata. The prototype drives teachers to set up a set of metadata that need to be associated to the course, modules and resources.
3. Contents navigation. The user is allowed accessing contents identified by metadata and keywords
4. Managing a social network of teachers. The social network supports the definition of communities around a specific disciplinary sector, whose objective is to transform a personal learning experience in a more collaborative and amazing one, obtaining better results. The social section is a mean for sharing materials in an informal way. While sharing, teachers can receive private or public feedbacks, which can help them in improving their contributions.

This report aims at presenting the results of a usability evaluation carried out on the current version of the SILMS in order to provide a set of guidelines for improving the usability of the next versions. According to these first feedbacks a new version of the SILMS has been developed and the report presents its renewed usability evaluation performed for highlighting how the previous usability issues have been fixed. In terms of the usability evaluations, a set of "Usability measures" has been adopted in relation to the number and severity of the evaluation problems discovered. Specifically in terms of experiments with users, the measures concern: The Completion Rate, that is the percentage of test participants who successfully complete the task without critical problems; The Problem-free Rate, that is the percentage of test participants who complete the task without any problems (critical or non-critical problems); The Time on Task (TOT), that is the time to complete a scenario. Finally, a set of subjective measures for collecting subjective opinions about specific tasks, time to perform each task, features, and functionality are surveyed. Moreover in order to evaluate the User Experience (UX) in experiments with teachers, we considered these "UX metrics": Computer System Usability Questionnaire and Subjective Measures for Satisfaction (IBM CSUQ and SUS rate); System usefulness, Information quality, Interface quality and Overall satisfaction Scale.

The System Usability Scale (SUS - ANNEX B) provides a "quick and dirty", reliable tool for measuring the usability. It consists of a 10 items questionnaire with five response options for respondents; from strongly agree to strongly disagree. Originally created by John Brooke in 1986, it allows us to evaluate a wide variety of products and services, including hardware, software, mobile devices, websites and applications.

The IBM CSUQ questionnaire (ANNEX C) was used for the subjective satisfaction measure since it has excellent psychometric reliability properties and benefits from a high correlation (r=0.94) between the system usability under evaluation and the answers to the 19 questions.

6.3 Methodology

One of the first steps in each round of usability testing is to develop a plan for the test. The purpose of the plan is to document what we are going to do, how we are going to conduct the test, what metrics we are going to capture, number of participants we are going to test, and what scenarios we will use.

The methodology is based on the above strategy for measuring usability by adopting both test and subjective metrics. The test metrics that we collected during the course of testing are: Successful Task Completion, Critical Problems, Non-Critical Problems, Problem-Free Rate and Time On Task. Instead, the subjective metrics include the questions we asked the participants prior to the sessions (e.g., background

questionnaire) and overall ease, satisfaction and likelihood to use/recommend questions when the sessions have been completed. These questionnaires consisted of a set of questions/statements designed to collect information from the respondent about usability, user satisfaction, knowledge, attitudes, opinions, behaviors, facts, and other information. In the following subsections we explain in detail how we recruited the participants, the procedure adopted during the test and the role of usability specialists involved in the experiment.

6.3.1 Participants

13 participants evaluated the SILMS. ANNEX A presents a complete report about the characteristics used for defining the participants' profiles. The participants' responsibilities were to attempt to complete a set of representative task scenarios presented to them in as an efficient and timely manner as possible, and to provide feedback regarding the usability and acceptability of the user interface. The participants have been driven to provide honest opinions regarding the usability of the application, and to participate in post-session subjective questionnaires and debriefing.

During the usability evaluation, 5 scenarios based on "real-life" tasks have been submitted to the participants. The tasks were presented in random order and participants were instructed about the SILMS project goals. The participants received an overview about: The usability test procedure, and Equipment and Software information for carrying out their activities.

Prior to conducting the usability test, we piloted test equipment and materials with volunteer participants. We ran the pilot test some days prior to the first test session so that we had time to deal with any technical issues, and to define the critical tasks at the base of each scenario to be tested. Moreover, the pilot test allowed us to:

- Test the equipment
- Provide practice for the facilitator and note-takers
- Get a good sense whether our questions and scenarios are clear to the participant
- Make any last minute adjustments

According to the results of the pilot test, the following tasks were identified:

#	Task
1	Couse Creation
2	Course Removal
3	Inserting new modules through the metadata search engine
4	Access to the SILMS Social Network
5	Creation of a personal folder in the SN

6.3.2 The procedure

Participants took part in the usability test in remote environments. Personal computers with the Web application and supporting software were used in a typical office environment. The participant's interactions with the Web application were monitored by the facilitator, by using Free Video Call Recorder of Skype. Note takers and data logger monitored the sessions, by using tools and services of Google Analytics. The test sessions were videotaped.

Participants took part in the usability test via remote screen-sharing technology. The participant was seated at their workstation in their work environment. Verbal communication was supported via Free Video Call Recorder of Skype.

The facilitator briefed the participant and instructed that he or she was evaluating the Web application, rather than the facilitator (in turn evaluating the participant). Participants completed a pretest demographic and background information questionnaire. Sessions began when all participant questions were answered by the facilitator. The facilitator informed the participant that time-on-task was measured.

The facilitator instructed the participant to read aloud the task description from the printed copy and begin the task. Time-on-task measure began. The facilitator encouraged the participants to "think aloud". The facilitator observed and entered user behavior and comments, and system interactions in a data logging application.

After all task scenarios were carried out, the participant completed the post-test satisfaction questionnaire.

6.3.3 Roles

The roles involved in a usability test were as follows:

Trainer: Provided training overview prior to usability testing

Facilitator:

- Provided overview of study to participants
- Defined usability and purpose of usability testing to participants
- Assisted in the conduction of the participants and observers debriefing sessions
- Responded to participant's requests for assistance

Data Logger: Recorded participant's actions and comments

Test Observers: Silent observer

6.3.4 Ethics

All persons involved with the usability test were required to adhere to the following ethical guidelines:

- The performance of any test participant was not individually attributable. Individual participant's name was not used in reference outside the testing session.
- A description of the participant's performance was not reported to his or her manager.

6.4 Implementation

The usability evaluation carried out for the SILMS has been conducted by a usability team in Milano along three months.

In this period, 13 participants were asked to spend one hour with the site. During this hour, participants:

- Completed a user background questionnaire
- Answered questions about initial site impressions
- Performed real-world tasks on the site while thinking aloud
- Answered questions about their overall satisfaction

In the following subsections we explain in detail how the methods discussed in the above section have been implemented on specific tasks and metrics.

6.4.1 Usability Tasks

The usability tasks were derived from test scenarios developed from use cases and with the assistance of subject-matter experts and by using the results of the pilot test. Due to the range and extent of functionality provided in the application, and the short time for which each participant were available, the tasks were the most common and relatively complex of available functions. The tasks were identical for all participants.

Task descriptions below were reviewed by the application owner, business-process owner, development owner, and/or deployment manager to ensure that the content, format, and presentation were representative of real use to substantially evaluate the total application. Their acceptance was documented prior to carrying out the usability test.

Task 1

Name: Couse Creation

Actors: user

Research questions: the objective of this task is to understand how tools for the creation of courses are intuitive and easy to understand.

Scenario:

This scenario aims at supporting the user in creating a course composed by three different modules. To complete this task the user has to register or authenticate himself by using the proper form in the SILMS, choose the category in which to create the course

and then add their own course naming it: "Business development". Then the user needs to enter the following metadata fields:

- The “Course short name” field: "BD1";
- The Keywords field: "Business, development, course, test";
- “Maximum Age” and “minimum age” field (the former bigger than the latter) required to study the course;
- “Background” field. This task asks to the user to select two types of skills required for the course and the related degrees of competence;
- “Acquired Skills Metadata” field concerns the skills acquired by the student as result to have attended the course and the related degrees of competence;
- The Description field: "Test course for business development".

After the creation of the course, the user has to manage the default settings form inside the course itself. Specifically, she/he has to insert the following metadata:

- The Module name: "Module A";
- The Summary: "Test module for business development";
- The Keywords: "Business, development, module, test";
- Difficulty: "Easy".

Subsequently, the user has to add two other modules, respectively named "Module B" and "Module C". Then, she/he has to manage metadata fields by using the same values used for the "Module A", with exception of the name.

Task 2

Name: Course Removal
Actors: user
Research questions: the objective of this task is to understand whether the procedure for the removal of their courses is easy to use.
Scenario:
The objective is to eliminate a course from the platform. To complete this task the user has to perform the following actions:

- She/he has to register or authenticate himself by using the proper form in the SILMS;
- She/he has to click “Site Administration > Courses > Add / Edit / Delete courses”;
- She/he has to search and delete the course "Business course test".

Task 3

Name: Inserting new modules through the metadata search engine
Actors: user
Research questions: the objective of this task is to understand if the strategy adopted for inserting new modules, by searching them through the metadata search engine, is understandable.
Scenario:
The goal is to include in the course named "Entrepreneurship course test" two existing modules through a search based on the metadata. Therefore the user has to register or authenticate himself by using the proper form in the SILMS, then she/he has to look for the course "Entrepreneurship course test" in the category "Entrepreneurial Vision" and perform the following actions:

- She/he has to click the button “Add modules through metadata”;
- She/he has to find the modules using the filters of the search engine.

Task 4

Name: Access to the SILMS Social Network
Actors: user
Research questions: the objective of this task is to understand if the “Home link” to access the SILMS Social Network is easy to locate, and if the user can easily understand how to access the service offered by Mahara System.
Scenario:
The objective is to log in the SILMS Social Network from the Home site page. Therefore, the user has to perform the following actions:

- She/he has to register or authenticate himself by using the proper form in the SILMS;
- She/he has to access the social platform through the appropriate link placed on the homepage;
- She/he has to return to the SILMS homepage using the appropriate link on the SILMS Social environment.

Task 5

Name: Creation of a personal folder in the SN

Actors: user

Research questions: the objective of this task is to understand if the strategy adopted for creating and transferring files in the SILMS Social Platform requires a user guide to help the users in their activities, or the process is easy to understand.

Scenario:

In this task the user has to create a personal folder in SILMS Social Network Platform. After the authentication, the user has to perform the following actions:

- She/he has to enter into the SILMS Social Platform;
- She/he has to click “Content > Files” command;
- She/he has to create a new personal folder named "Social Network files";
- She/he has to upload an empty text file;
- She/he has to create a new personal folder named "Subfolder Social Network";
- She/he has to enter a text file into the folder "Subfolder Social Network";
- She/he has to enter the folder "Subfolder Social Network" into the folder "Social Network files".

6.4.2 Usability Design

Usability Metrics

Usability metrics refer to the user performance measured against specific performance goals necessary to satisfy usability requirements. Scenario completion success rates, adherence to dialog scripts, error rates, and subjective evaluations were used. Time-to-completion of scenarios was also collected.

Scenario Completion

Each scenario requires that the participant obtains or inputs specific data that would be used in the course of a typical task. The scenario is completed when the participant indicates the scenario's goal has been obtained (whether successfully or unsuccessfully) or the participant requests and receives sufficient guidance as to warrant scoring the scenario as a critical problem.

Critical problems

Critical problems are deviations at completion from the targets of the scenario. Obtaining or otherwise reporting of the wrong data value due to participant workflow is a critical problem. Participants may or may not be aware that the task goal is incorrect or incomplete.

Independent completion of the scenario is a universal goal; help obtained from the other usability test actors is a cause to score the scenario a critical problem. Critical problems can also be marked when the participant initiates (or attempts to initiate) an action that results in a goal state becoming unobtainable. In general, critical problems are unresolved problems during the process of completing the task or problems that produce an incorrect outcome. In the SILMS platform critical problems concern problems in creating, deleting or modifying courses/modules (Tasks: 1, 2 and 3) and in interacting with the social Network platform (Tasks: 4 and 5).

Non-critical problems

Non-critical problems are problems that are recovered from by the participant or, if no detected, do not lead to processing problems or unexpected results. Although non-critical problems can be undetected by the participant, when they are detected they prove generally frustrating the participant.

These problems may be procedural, where the participant does not complete a scenario in the optimal means (e.g., excessive steps and keystrokes). These problems may also be due to confusion (ex., initially selecting the wrong function, using a user-interface control incorrectly such as attempting to edit an un-editable field).

Noncritical problems can always be recovered during the process of completing the scenario. Exploratory behavior, such as opening the wrong menu while searching for a function, is coded as a non-critical problem.

Subjective Evaluations

Subjective evaluations regarding ease of use and satisfaction are collected via questionnaires, and during debriefing at the conclusion of the session. The questionnaires are based on IBM CSUQ and SUS questionnaire by using closed-form responses and rating scales.

Scenario Completion Time

The time to complete each scenario, not including subjective evaluation durations, has been recorded.

6.4.3 Usability Goals

We here describe the usability goals adopted during the evaluation of the SILMS.

Completion Rate

Completion rate is the percentage of test participants who successfully complete the task without critical problems. A critical problem is defined as a problem that results in an incorrect or incomplete outcome. In other words, the completion rate represents the percentage of participants who, when they are finished with the specified task, have an "output" that is correct. Note: If a participant requires assistance in order to achieve a correct output then the task is scored as a critical problem and the overall completion rate for the task is affected.

A completion rate of [100%/enter completion rate] is the goal for each task in this usability test.

Problem-free rate

Problem-free rate is the percentage of test participants who complete the task without any problem (critical or non-critical problem). A non-critical problem is a problem that would no have an impact on the final output of the task but would result in the task being completed less efficiently.

A Problem-free rate of [80%/problem error-free rate] is the goal for each task in this usability test.

Time on Task (TOT)

The time to complete a scenario is referred to as "time on task". It is measured from the time the person begins the scenario to the time he/she signals completion.

Subjective Measures

Subjective opinions about specific tasks, time to perform each task, features, and functionality have been surveyed. At the end of the test, participants rated their satisfaction with the overall system. Combined with the interview/debriefing session, these data have been used to assess attitudes of the participants.

6.4.4 Problem Severity

To prioritize recommendations, a method of problem severity classification has been used in the analysis of the data collected during evaluation activities. The approach treats the problem severity as a combination of two factors - the impact of the problem and the frequency of users experiencing the problem during the evaluation.

Impact

We rank the Impact of the problem in terms of the consequences that the problem has on successful task completion. There are three levels of impact:

- **High** - prevents the user from completing the task (critical problem)
- **Moderate** - causes a user difficulty but the task can be completed (non-critical problem)
- **Low –** causes minor problems that do not significantly affect the task completion (non-critical problem)

Frequency

Frequency is the percentage of participants who experience the problem when working on a task.

- **High**: 30% or more of the participants experience the problem
- **Moderate**: 11% - 29% of participants experience the problem
- **Low**: 10% or fewer of the participants experience the problem

Problem Severity Classification

The identified severity for each problem implies a general reward for resolving it, and a general risk for not addressing it in the current release.

Severity 1 - High impact problems that often prevent a user from correctly completing a task. They occur in varying frequency and are characteristic of calls to the Help Desk. Reward for resolution is typically exhibited in fewer Help Desk calls and reduced redevelopment costs.

Severity 2 - Moderate to high frequency problems with moderate to low impact are typical of erroneous actions that the participant recognizes need to be undone. Reward for resolution is typically exhibited in reduced time on task and decreased training costs.

Severity 3 - Either moderate problems with low frequency or low problems with moderate frequency; these are minor annoyance problems faced by a number of participants. Reward for resolution is typically exhibited in reduced time on task and increased data integrity.

Severity 4 - Low impact problems faced by few participants; there is low risk of doing not resolve these problems. Reward for resolution is typically exhibited in increased user satisfaction.

6.5 Results of the usability tests

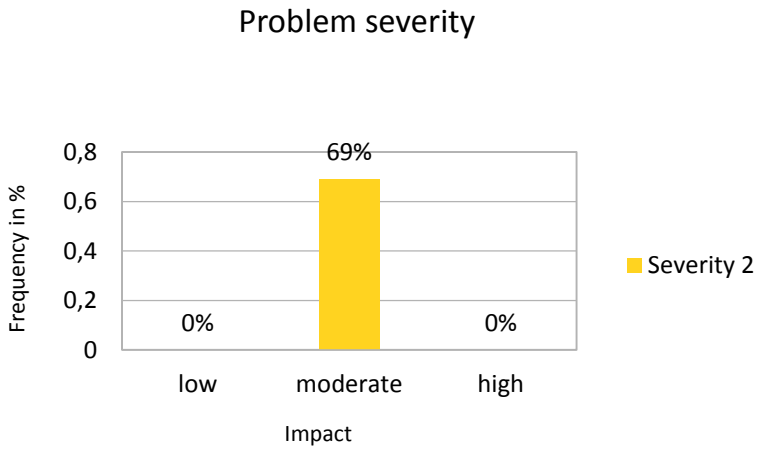
This section presents the result of a first usability test carried out on the SILMS according to the scenarios described in section 6.4.2. The results of this usability evaluation provided a set of guidelines for improving the usability of a second SILMS version.

6.5.1 First Usability test

Task 1: Couse Creation

Add new modules

Percentage of requested assistance	39 %
Type of suggestions provided to the users	Indicated the button to add new modules
User Comments	It is not easy to identify the button for adding new modules. It is not intuitive.
Impact	Moderate - Non-critical problems
Frequency	69 % - High



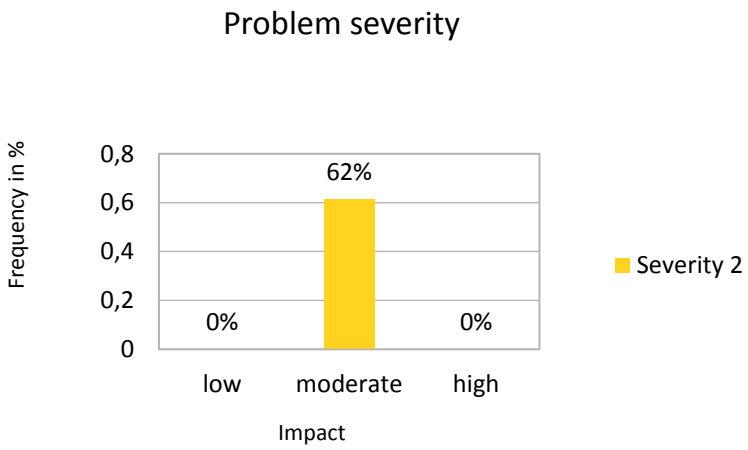
Solutions:

The idea is to replace the label of the button for adding new modules with the phrase "Add a new module". The button has to be graphically similar to the existing ones.

Task 2: Course Removal

Percentage of task completed	93 %
Percentage of requested assistance	0 %
Type of suggestions provided to the users	no suggestions
Avg TOT	00.04.23 (hh,mm,ss)
Avg click	14
Notes	85 % of users have used the search engine button

Percentage of task completed	93 %
User Comments	It is not easy to understand how to delete a course. I expected to have a menu that contains the courses through which to manage/delete a course. It is not intuitive.
Impact	Moderate - Non-critical problems
Frequency	62 % - High

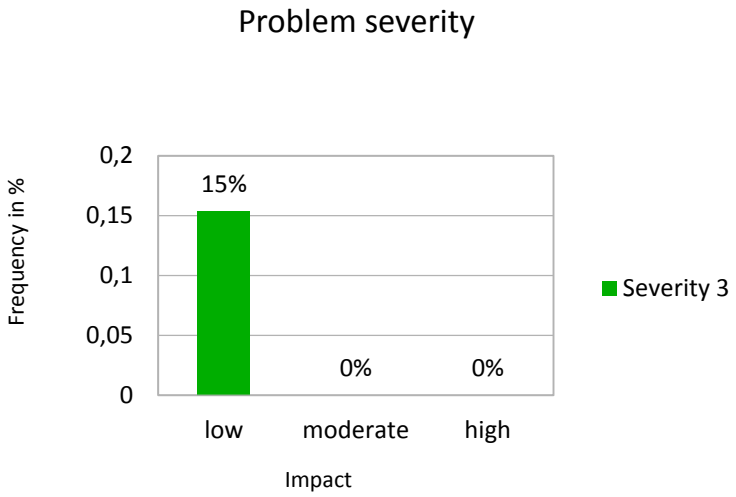


Solutions:

The idea is to replace the sub-item "Add / edit courses", inside the block "Administration", in "Add / Edit / Remove courses." Moreover, in the "Add / Edit courses", we need to replace the list of categories, with a list of classes or the class of membership if the authenticated user is not an Administrator.

Task 3: Inserting new modules through the metadata search engine

Percentage of task completed	100 %
Percentage of requested assistance	0 %
Type of suggestions provided to the users	no suggestions
Avg TOT	00.05.13
Avg click	8
User Comments	no comments
Impact	Low - Non-critical problems
Frequency	15 % - Moderate

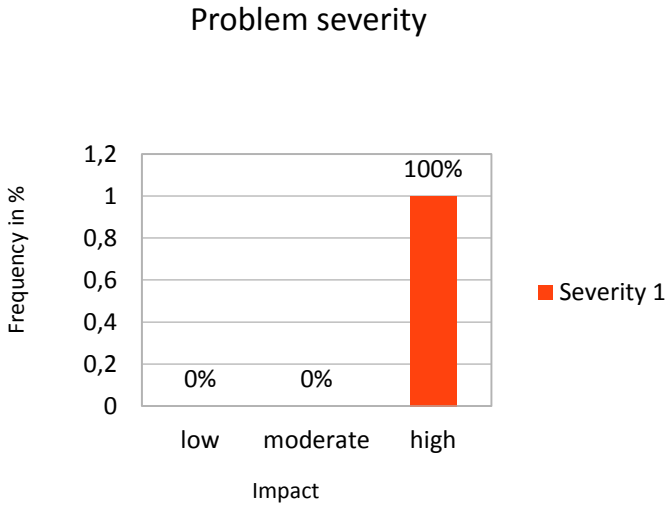


Solutions: no changes to be made.

Task 4: Access to the SILMS Social Network

**** In the test phase, the Social platform is still an early prototype and is not present the multi-language component***

Percentage of task completed	46 %
Percentage of requested assistance	0 %
Type of suggestions provided to the users	no suggestions
Avg TOT	00.01.50
Avg click	4
User Comments	The link for entering into the Social Platform and the link for returning to the homepage are not evident and intuitive.
Impact	High – critical problem
Frequency	100 % - High



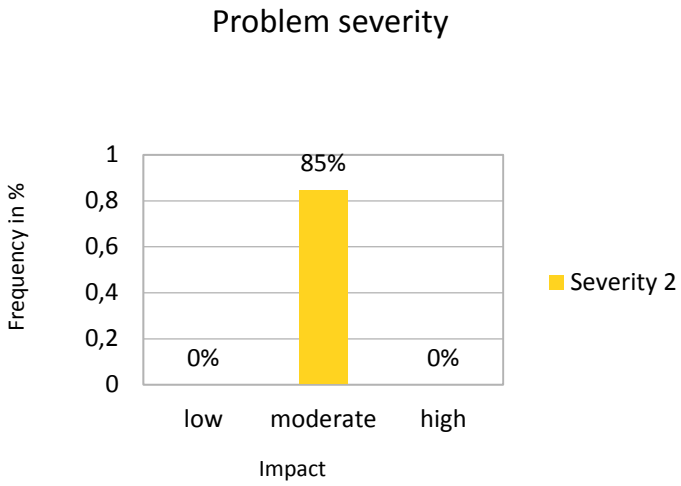
Solutions:

The idea is to highlight the links and to replace the link "Home-Mahara" in " SILMS Social Network" or " SILMS Social". Finally, we need to replace the link to return to the “SILMS homepage” in "Back to the SILMS " or “SILMS”.

Task 5: Creation of a personal folder in the SN

**** In the test phase, the Social platform is still an early prototype and is not present the multi-language component***

Percentage of task completed	46 %
Percentage of requested assistance	0 %
Type of suggestions provided to the users	no suggestions
Avg TOT	00.06.03
Avg click	11
User Comments	It is not intuitive the interface that I have to use for creating folders. The English version is not present.
Impact	Moderate - Non-critical problems
Frequency	85 % - High



Solutions:

We need to implement a multi-language translation of the Social Platform and to insert small explanations, or highlight those already present, near the links and buttons.

6.5.2 Second Usability test

According to these first feedbacks a new version of the SILMS has been carried out and in this section a new usability evaluation is described in order to highlight how the previous usability issues have been fixed

Task 1: Couse Creation

Percentage of task completed	100 %
Percentage of requested assistance	0 %
Type of suggestions provided to the users	---
Avg TOT	00.07.40
Avg click	11
User Comments	---
Impact	---
Frequency	---

Task 2: Course Removal

Percentage of task completed	100 %
Percentage of requested assistance	0 %
Type of suggestions provided to the users	---

Percentage of task completed	100 %
Avg TOT	00.00.57
Avg click	7
User Comments	---
Impact	---
Frequency	---

Task 3: Inserting new modules through the metadata search engine

Percentage of task completed	100 %
Percentage of requested assistance	0 %
Type of suggestions provided to the users	---
Avg TOT	00.01.17
Avg click	4
User Comments	---
Impact	---
Frequency	---

Task 4: Access to the SILMS Social Network

Percentage of task completed	100 %
Percentage of requested assistance	0 %
Type of suggestions provided to the users	---
Avg TOT	00.00.37
Avg click	3
User Comments	---
Impact	---
Frequency	---

Task 5: Creation of a personal folder in the SN

Percentage of task completed	100 %
Percentage of requested assistance	0 %
Type of suggestions provided to the users	---
Avg TOT	00.03.40
Avg click	7
User Comments	---
Impact	---
Frequency	---

6.6 Conclusion – User satisfaction

SUS questioner (first ten questions)

We assigned to the user replies a value using the scale 1-5 (where 1 is “strongly disagree” and 5 is “strongly agree”). We normalized these values according to the SUS scale taking into account the negative or positive connotation of each item (the odd items have a positive connotation and the even ones a negative connotation). The values have been added according to this SUS caring calculation:

- For odd items: subtract one from the user response.
- For even-numbered items: subtract the user responses from 5
- This scales all values from 0 to 4 (with four being the most positive response).
- Add up the converted responses for each user and multiply that total by 2.5. This converts the range of possible values from 0 to 100 instead of from 0 to 40.

The final result is not a percentage but a value that is more positive if it is close to 100. According to the SUS protocol a result can be considered positive if it is more than 638. The image (Figure 40) below shows how the percentile ranks associate with SUS scores and letter grades.

The SUS result of the first analysis is 53, hence lower than the sufficiency threshold. The same value in percentile is 17 % and the grade is D. Instead, the SUS score of the second analysis is 63, therefore still under the sufficiency but in percentile is 36 % with grade C, highlighting an increasing result in respect with the first analysis.

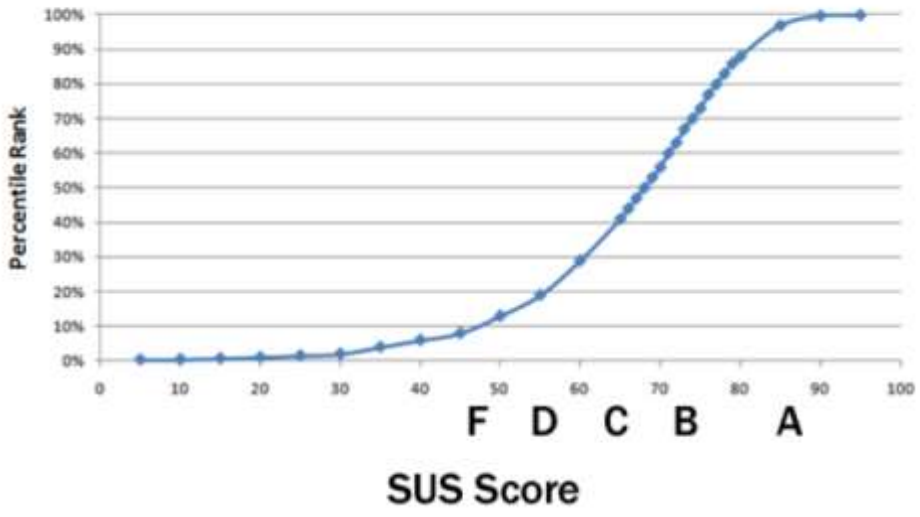


Figure 40 Percentile ranks associate with SUS scores and letter grades

CSUQ (last nineteen questions)

In order to clarify what problems caused a result under the sufficiency threshold in both the analyses, it is necessary to evaluate the result of a second set of questions reported into the questionnaires provided to the participants. Also in this case we assigned to the replies a value using the scale 1-5 (where 1 is “strong disagree” and 5 is “strong agree”). The average of the replies was also evaluated according to a cluster of issues for focusing the attention on specific aspects of the system.

- SYSUSE (items from 1 to 8 plus item 19): For measuring the utility of the SILMS. Result: 3,89
- INFOQUAL (item 9-15): For measuring the quality of the information. Result: : 3,71
- INTERQUAL (items 16-18): for measuring the quality of the interface. Result: 3,67
- OVERALL (all items): For measuring the general satisfaction. Result: 3,79

Since the results are on the scale 1-5 (where 5 is the better value), we can claim that the weak point of our system is the interface considering that the INTERQUAL has the lowest value. Instead, the better result is the SYSUSE and so we can claim that the participants had the impression that our system is useful.

6.7 Annex A. Participants' profiles

Audience Type	
University professor / Teacher	46 %
Freelancer / Consultant	31 %
Retired	8 %
Undergraduate	15 %
TOTAL (participants)	100 %

Gender	
Women	69 %
Men	31 %
TOTAL (participants)	100 %

Age	
26-39	46 %
40-59	46 %
60-74	8 %
< 75	0 %
TOTAL (participants)	100 %

Qualification	
University degree	77 %
High school graduation	23 %
TOTAL (participants)	100 %

Known languages	
English	92 %
French	46 %
German	15 %
Spanish	31%
Chinese	8 %
Bulgarian	8 %
Italian	92 %

Participation in usability testing in the last 6 months	
Yes	62 %
No	38 %
TOTAL (participants)	100 %

Note: Every user knows more than one language

Computer Usage

0 hrs. wk.	0 %
1 to 10 hrs. wk.	15 %
11 to 25 hrs. wk.	15 %
26 to 40 hrs. wk.	39 %
40+ hrs. wk.	31 %
TOTAL (participants)	100 %

Computer activities

Game / Entertainment	0 %
Read news	0 %
Commercial / banking	8 %
Graphic design / digital pictures	8 %
Programming / word processing	76 %
Other	8 %
TOTAL (participants)	100 %

Operating system

Mac os x	8 %
Windows 7	61 %
Windows 8	23 %
Lion os x	8 %
TOTAL (participants)	100 %

Browser

Google Chrome	31 %
Internet Explorer	38 %
Mozilla Firefox	23 %
Safari	8 %
TOTAL (participants)	100 %

E-learning website visited

1 to 2 time . yr.	38 %
1 to 2 time. Mth.	8 %
1 to 2 time . wk.	23 %
About every day	31 %
Never	0 %
TOTAL (participants)	100 %

E-learning platform to support the teaching activities

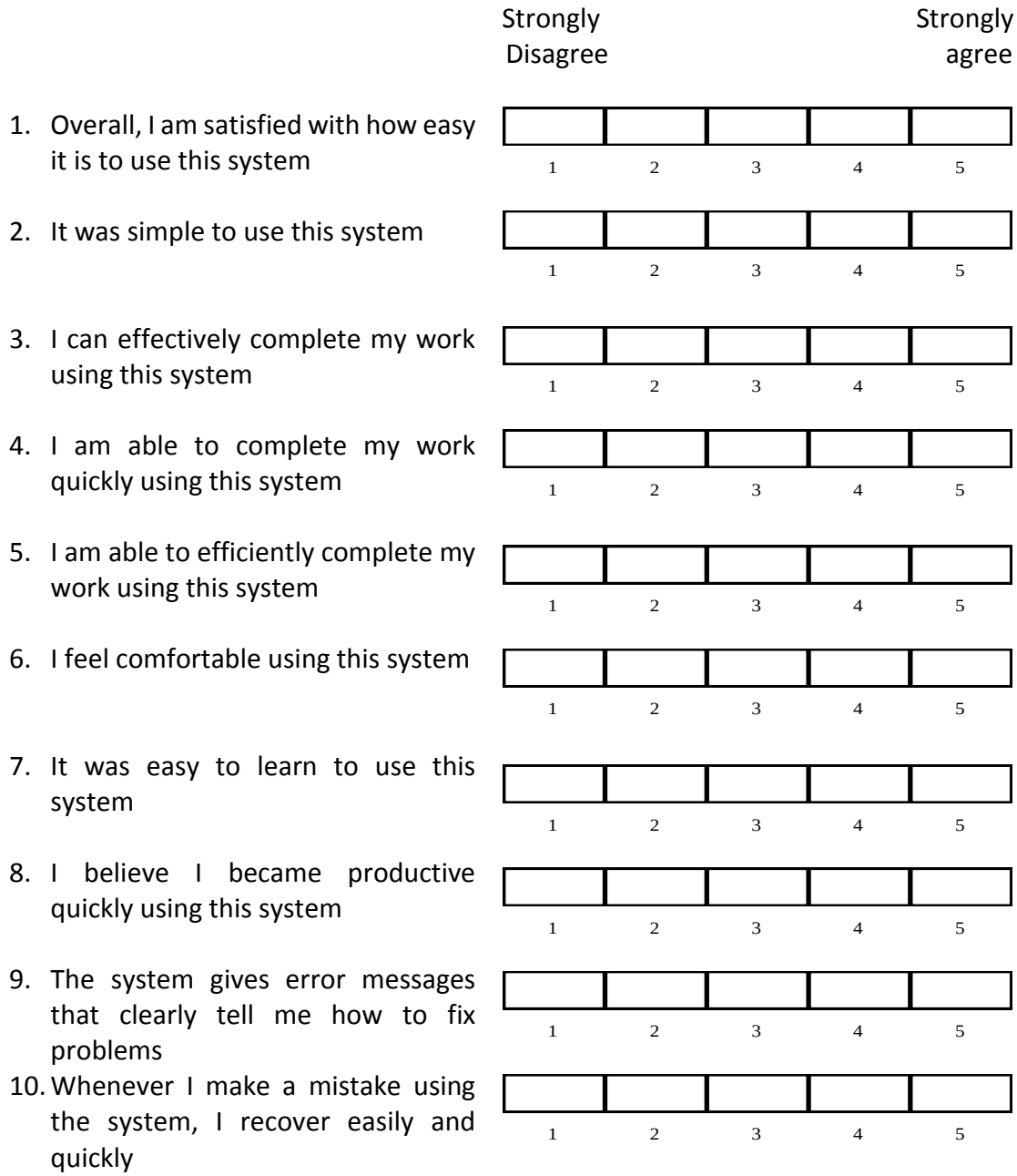
Moodle	54 %
No any	46 %
Other	0 %
TOTAL (participants)	100 %

Entrepreneurial experience					
Level of expertise	**Entrepreneurial Vision**	**Personal Development**	**Communication Skills**	**Economic Skills**	**Technical Skills**
1	38 %	8 %	23 %	38 %	15 %
2	0 %	8 %	0 %	38 %	15 %
3	23 %	23 %	31 %	15 %	0 %
4	31 %	15 %	23 %	8 %	38 %
5	8%	46 %	23 %	1 %	32 %
tot	100%	100%	100%	100%	100%

6.8 Annex B. SUS - A quick and dirty usability scale

	Strongly Disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

6.9 Annex C. IBM CUSQ: Computer Usability Satisfaction Questionnaires



11. The information (such as online help, on-screen messages, and other documentation) provided with this system is clear

1	2	3	4	5

12. It is easy to find the information I needed

1	2	3	4	5

13. The information provided for the system is easy to understand

1	2	3	4	5

14. The information is effective in helping me complete the tasks and scenarios

1	2	3	4	5

15. The organization of information on the system screens is clear

1	2	3	4	5

16. The interface of this system is pleasant

1	2	3	4	5

17. I like using the interface of this system

1	2	3	4	5

18. This system has all the functions and capabilities I expect it to have

1	2	3	4	5

19. Overall, I am satisfied with this system

1	2	3	4	5

7. A COGNITIVE RECOMMENDER SYSTEM

7.1 Summary

We introduce a new recommending paradigm based on the genomic features of the candidate objects. The system is based on the tree structure of the object metadata which we convert in acceptance rules, leaving the user the discretion of selecting the most convincing rules for her/his scope. We tested the deriving recommendation system on a content management platform within the scope of the SLMS for the case study European Project NETT. This chapter is organized as follows. In Section 2 we provide a short survey on existing recommender systems. In Section 3 we explain the new method we propose and the implementation tools, while in Section 4 we frame the proposed RS in the NETT benchmark and discuss some case study experiments, aimed at testing the algorithms efficacy. Finally, in Section 5 we discuss the user experience on the recommender system by facing exactly the courses creation task.

7.2 The state of the art

In recent years we have seen a remarkable proliferation of recommender systems (RSs) in most disparate fields, ranging from movies, music, books, to financial services and live insurances. Usually implemented as web applications, they constitute a class of algorithms aimed at predicting user responses to options, by generating meaningful recommendations to a collection of users for items that might be of their interest.

A RS generates and provides recommendations following three phases:
1) the user provides input to the system which is explicit (e.g. feedback or ratings of resources) and/or implicit (e.g. resources visited and time spent on them);
2) the inputs are processed in order to obtain a representation that allows one to infer user interests and preferences, that is, to build a “user model". This representation could be given either as a simple matrix rating of products (texts, lessons, movies), or in terms of more complex data structures that combine rating and content information;
3) the system processes suggestions using the user model, assigning to the recommendation a suitable confidence level.
While initially RSs were based on standard statistical techniques [49] , such as correlation analysis, in recent years predictive modeling, machine learning and data mining techniques were engaged in this involving challenge. Mainly, this happened when both the scientific community and practitioners recognized the many issues such methods may conceal, in order to produce meaningful and high-quality results in a wide spectrum of real-world scenarios. From then on, RSs have been investigated under the hat of various well-known branches of machine learning and data mining, such as classification, clustering, and dimensionality reduction techniques, by specializing them to the peculiar aspects of RSs. Traditionally RSs have been classified into three main categories:

1. Collaborative Filtering (CF) Systems: users are recommended items based on the past ratings of all users collectively. CF can be further subdivided into

neighborhood-based (computing a prediction through a k-nearest neighbor (kNN) approach from a weighted combination of neighbors rating, where neighboring users are those having highest similarity with the questioned user [50] and model-based approaches (treating the recommendation problem as a parametric estimation task [51]). In the latter group, latent variable models [52] have gained much popularity in recent years: here, to compute the similarity between users and items, some hidden lower-dimensional structure in the data is discovered through either numerical linear algebra and statistical matrix analysis [53] , or more sophisticated manifold learning techniques [54]. Current research in CF systems is directed toward the ensemble of different models and their enhancements through factorization techniques [55].

2. Content-Based (CB) Systems: only those preferences of the user waiting for suggestions are involved in the recommendation process. These systems try to suggest products/resources that are similar to those that the user has liked in the past. CB systems are usually subdivided into Information Retrieval [56] (where the content associated with the user preferences is treated as a query, and the unrated documents are scored with relevance/similarity to it) and classification tasks (where each example represents the content of an item, and a user past ratings are used as labels for these examples). Algorithms such as Naive Bayes classifiers [57], k-nearest neighbor, decision trees, and neural networks [51] represent the state-of-the-art in the field.
3. Hybrid Recommendation Systems: these hybrid systems aim to achieve the advantages of content-based and collaborative filtering systems, combining both approaches in order to mitigate the limitations associated with the use of one or the other type of system. To cite a few examples, ensemble methods, such as boosting techniques [58], are used to aggregate the information provided by CF and CB systems; alternatively, such information may be combined under a single probabilistic framework in the form of a generative model [59].

Less known but likewise relevant, we mention two more families having received the attention of the scientific community in the last years (see Fig. 41 taken from [60]):

- Demographic recommender systems, based on demographic classes. Personal information is gathered around user stereotypes. Such demographic groups are used, for instance, to suggest a range of products and services [61]. The classes may be identified by short surveys, machine learning methods, or correlation techniques. The benefit of a demographic approach is that it may not require a history of user ratings, which is needed, on the contrary, by collaborative and content-based techniques.
- Utility-based and knowledge-based RSs, both rooted on the evaluation of the match between a user need and the set of available options. Thus, the user profile is the utility function, and the system employs constraint satisfaction techniques to locate the best match. Scientific research has concentrated in

discovering the best techniques for identifying and exploiting the user-specific utility function [62].

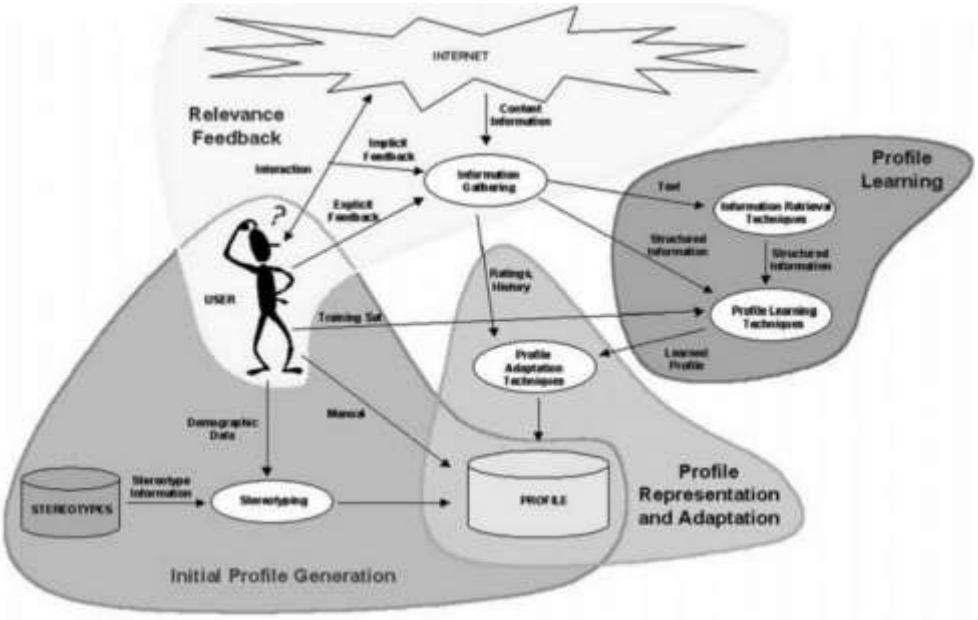


Figure 41 A synopsis of recommender systems

Technically, the recommendation task is currently afforded as a combination of learning algorithms, statistical tools, and recognition algorithms, the areas ascribed to the study of computational intelligence. Facing a huge base of data, a common action to exploit them is their compression, either through statistical methods, such as independent components analysis, or through logical methods, such as cluster analysis and decision trees. Both families are aimed at extracting relevant features, possibly by a simple selection, mostly by a generation of new ones. Roughly speaking, we may consider the former methods routed on the phenotypic features and the latter on the genotypic ones – the seeds of most learning procedures. Our RS too passes through this genotypic compression, with the methodological option of offering the data genotypes as a former suggestion to the user, and a subsequent screening of the available resources filtered through the genotypes selected by the user, exactly like it happens in DNA microarray analysis [63].

With reference to the above taxonomy, our method falls in the CB Systems category, where in terms of recommender strategies we propose entropic utility functions. These are particularly suited for the application instance we will consider, within the scope of the SILMS for the NETT case study. However, given the adimensionality features of the entropy-based reasoning, we expect the method to prove efficient in many operational fields.

7.3 The method and its implementation tools

The main idea supporting the proposed human-centric algorithm is to guide the teacher in the selection of the didactic resources more suitable to his purposes through several

phases, each one aimed at reducing the huge number of available resources. In such a way, the teacher may incrementally focus only on those subsets of resources really pertaining to her courses without being frustrated in browsing the whole dataset.

Due to: i) the heterogeneity of the various courses, modules and lessons; ii) the huge amount of resources appearing in the dataset; and iii) the unknown preference of the teacher in terms of topics covered by the course he is preparing (which are to be inferred through a agnostic paradigm), we split the recommender system functionality into three main parts, according to the schema reported in Algorithm 1. In all phases, it emerges the human-centric feature of the proposed Recommender System. In fact, the teacher plays a primary and active role in the design of her course. The system itself is asked to assist the teacher in all his choices, suggesting the most suitable moves she may take at each step of the algorithm. The three phases have been designed exactly to tackle the three main features of the task in question: i) a course is usually composed by many parts; some of them are indispensable for its success, some others stay in the background (for instance the course introduction and conclusion); aim of the first phase is to automatically discover which are the most relevant parts of a course; ii) the teacher is the only actor which knows the topics of the course; the goal of the second phase is to infer these topics by guiding the teacher in the selection of the most suitable metadata, in the meanwhile avoiding his frustration and dissatisfaction; and iii) the repository may contain a huge amount of resources; aim of the third phase is to help the teacher to select the resources which better suit the course topics in a small number of steps.

Algorithm 1 Schema of the proposed Recommender System.

```
1: procedure CREATECOURSE(dataset)
2:     repeat
3:         1. Select the most informative part of the course
4:         2. Choose the metadata mostly relevant to the selected part
5:         3. Select the resources filling the selected part
6:     until the course is complete
7: end procedure
```

Figure 42 Schema of the proposed Reccomender System

In more technical terms, consider a set of N records, each consisting of m fields characterizing objects of our interest. Call these fields metadata μis and the objects payloads $\pi$is. We distinguish between qualitative (nominal/ordinal) and quantitative (continuous/discrete) metadata, where the latter are suitably normalized in [0,1].
Moreover each record is affected by a rank *p*, typically normalized in [0, 1] as well.

The RS goal is to understand the structure of the feature set corresponding to records ranked from a given threshold on. Note that we are not looking for a metadata-rank regression. Rather, we prefer considering a binary attribute (acceptable, not acceptable) and ask the user to select among acceptable genomes.

In essence, our goal is to infer a set of rules in the Horn clauses format, made of some antecedents and one consequent. The consequent is fixed: "π_i is good".
The antecedents are Boolean conditions cj (true/false) concerning sentences of two kinds: i) "μi ≤/> θi", where θ stands for any symbolic (for nominal metadata) or numeric constant (for quantitative variables); and ii) "μi $\in$ A", with A a suitable set of constants associated with enumerated, hence qualitative, metadata. Hence the format is the following:

if $c_1$and c_2 … **and** c_k **then** π_i is good (1)

We may obtain these rules starting from one of the many algorithms generating decision trees dividing good from bad items, where the difference between the various methods stands in the entropic criteria and the stopping rules adopted to obtain a tree, and in the further pruning heuristics used to derive rules that are limited in number, short in length (number of antecedents), and eficient as for classification errors. In articular we use RIPPERk, a variant of the Incremental Reduced Error Pruning (IREP) proposed by Cohen [64] to reduce the error rate, guaranteeing in the meanwhile a high efficiency on large samples, and in particular its Java version JRip available in the WEKA environment [65]. This choice was mainly addressed by computational complexity reasons, as we move from the cubic complexity in the number of items of the well known C4.5 [66] to the linear complexity of JRip. Rather, the distinguishing feature of our method is the use of these rules: not to exploit the classification results, rather to be used as hyper-metadata of the questioned items. In our favorite application field, the user, in search of didactic material for assembling a course on a given topic, will face rules like those reported in Figure 43. Then, it is up to her/him to decide which rules characterize the material s/he's searching for.

Id	Rule
R_1	*skill_required* Communication Skill in Marketing Information Management = low **and** *language* = Italian ⇒ *good_course*
R_2	*skill_acquired* Communication Skill in Marketing Information Management = medium-high **and** *skill_acquired* Communication Skill in Communications Basic = high **and** *age* = teenager-adult ⇒ *good_course*

Figure 43 A set of two candidate rules

The last phase of the procedure is rather conventional. Once the rules have been selected, the system extracts all payloads $\pi$is (i.e. didactic resources in our favorite scenario) satisfying them, which will then be further explored via keywords, describing the topics of each didactic resource. The latter have been previously extracted by each πi so as to constitute their labels. Thus the algorithm looks for the best keyword selection in terms of the ones providing the highest entropy partition of the extracted π_is (see Figure 44). With this strategy, we are guaranteed that the number of selected

resources still reduces uniformly at an exponential rate for whatever keyword subset chosen by the user.

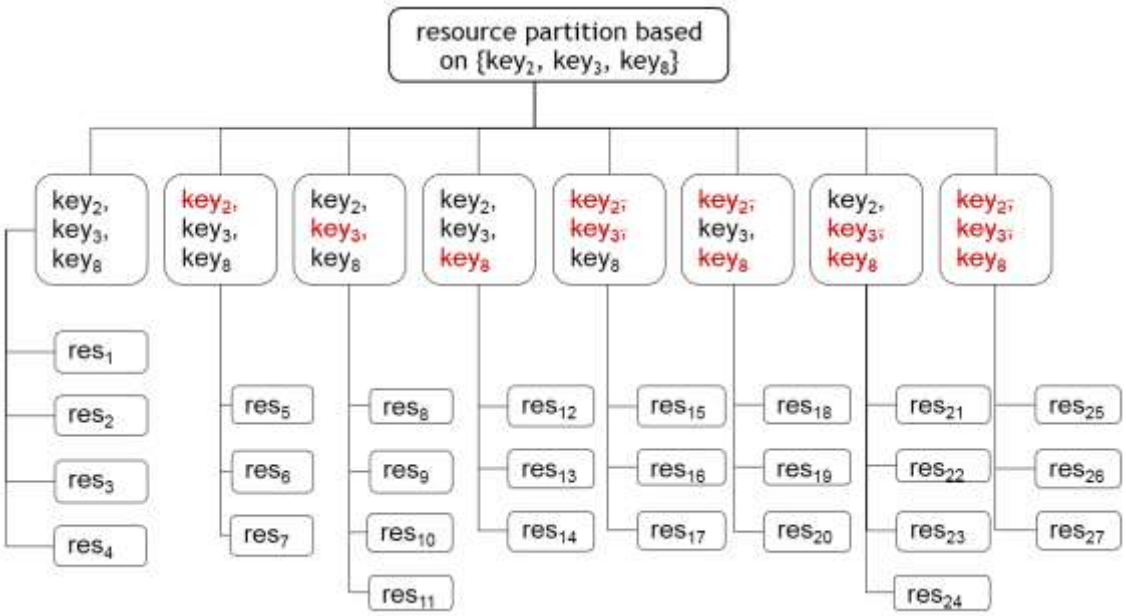


Figure 44 The keyword subset selection process. The number of resources reduces uniformly, independently from the choice of the user (branch in the picture)

7.4 Numerical results

Is genotypic recommendation more efficient that the phenotypic one?
Our target application is a RS supporting the SILMS in guiding the user exploration to assemble a new course on Entrepreneurship Education. Given the relatively novelty of this discipline, the platform collects didactic materials - books, articles, slides, and didactic projects: didactic objects for short - to be consulted by teachers in order to build up a new course in the field. Given the social nature of the platform, on the one hand we may expect its repository to be populated by a huge number of didactic objects $\pi$is (order of ten thousand).

192	N	192	N	175	R	175	R	166											
175	R	175	R	166	Q	166	Q	44											
333	N	333	N	460	P	460	P	222	M	222	M	34	M	34	M	99			
17	N	17	N	107	N	107	N	192	L	469	L	469							
53	M	53	M	166	M	166	M	166	L	397	L	397							
407	N	407	N	407	Q	407	Q	407	S	407	S	496	L	635	L	635			

Figure 45 Some restaurant paths

On the other hand, we may expect a teacher to be available to deeply examine some dozens of them. Hence the RS must help her/him to extract the most suitable objects from the repository. While its user experience test will be discussed in the next section, in this section, we refer to the restaurant recommendation case study, initially

considered by Burke [67], in order to state some quantitative considerations on the performance of our procedure.
The Entree Chicago recommendation benchmark is available in the UCI KDD repository [68]. Apart from ancillary data, it consists of sequences of pairs <restaurant id, next action label> as shown in Figure 45. The former refers to Chicago restaurants; they are proposed by a web-service in response to a user solicitation. The first id is the suggestion of the service as a result of some options selected by the user, concerning kind of food, glamor, cost, etc. Next ids are suggestions again in response to the action requested by the user through the labels in the second part of the pair - whose meaning is reported in Figure 46.

Label	Description
L	browse (move on the next restaurant in a list of recommendations)
M	cheaper (search for a restaurant like this one, but cheaper)
N	nicer (search for a restaurant like this one, but nicer)
O	closer (closer to my house)
P	more traditional (serving more traditional cuisine)
Q	more creative (serving more creative cuisine)
R	more lively (with a livelier atmosphere)
S	quieter (with a quieter atmosphere)
T	change cuisine (serving a different kind of food)

Figure 46 The possible asctions performed by the user in search of a better restaurant

The last pair in a sequence has the second element empty, thus denoting that no further action is required since the last restaurant is considered satisfactory. We processed these records, in number of 50.672 through JRip and PART [69], an algorithm present in the WEKA environment, which builds a partial C4.5 decision tree in each iteration and makes the best leaf into a rule. From a preliminary survey of the results we decided to focus on JRip, looking at the main benefit that a great part of records is discriminated by a short number of rules. Namely, of the 15.493 records leading to a good restaurant selection, 90% are recognized by 20% of the rules. These quantities have to be considered as an average behavior. Indeed, first of all we must decide which records are good and which bad. We decree as bad records those having a percentage of L labels greater than 40 or 50% (glimpse values). Then, another questionable parameter is the truncation of the records to be submitted to the rule generator. Recognizing that 90% of records have a length up to 8, we decided to generate rules by submitting records truncated to a number of pairs ranging between 5 and 8 (*trunc* values). Thus, our consideration comes from mediating 8 different rule generation scenarios. A further preprocessing of the data comes from the will of removing noise, that we assume coinciding both with rules satisfied by a very few records, for instance 0.3% of the total, and with restaurant visited, as starting point or ending point of the records, a very small number of times, for instance up to 2 or 3. With this shrinking of the database, we came to the following conclusions:

- The rules well separate the records, with an average overlapping rate less than 20%, reducing to 10% in the best case (see Figure 47).
- The basins of attraction of these rules is very limited. Namely, starting from the first restaurant suggested by the Entree web-service, a rule brings unequivocally to one or two ending restaurants (few exceptions apart concerning the less-frequent/noise restaurant (see above) independently from the action taken by the user. On the opposite direction, a given restaurant is reached by a limited number of starting ones, with some exceptions for a few restaurants which gather much many sequences. This is shown by the two histograms in Figure 48.

	r_1	r_2	r_3	r_4	r_5	r_6	r_7	r_8	r_9	r_{10}	r_{11}	r_{12}	r_{13}	r_{14}	r_{15}	r_{16}	r_{17}
r_1	9110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
r_2	0	423	0	0	0	0	0	0	98	25	35	16	0	0	1	0	0
r_3	0	0	117	0	0	0	0	0	11	4	8	8	0	0	0	0	0
r_4	0	0	0	1838	0	0	0	0	0	0	0	0	0	0	0	0	0
r_5	0	0	0	0	130	0	0	0	4	8	18	4	0	0	1	0	0
r_6	0	0	0	0	0	120	0	0	7	13	5	11	0	0	1	0	0
r_7	0	0	0	0	0	0	1604	0	0	0	0	0	0	0	0	0	0
r_8	0	0	0	0	0	0	0	52	4	4	1	7	0	0	0	0	0
r_9	0	98	11	0	4	7	0	4	210	0	0	0	0	0	0	3	0
r_{10}	0	25	4	0	8	13	0	4	0	80	0	0	1	0	0	0	4
r_{11}	0	35	8	0	18	5	0	1	0	0	91	0	0	0	0	2	1
r_{12}	0	16	8	0	4	11	0	7	0	0	0	68	0	0	0	1	0
r_{13}	0	0	0	0	0	0	0	0	0	1	0	0	6	0	0	0	0
r_{14}	0	0	0	0	0	0	0	0	0	0	0	0	0	19	2	0	0
r_{15}	0	1	0	0	1	1	0	0	0	0	0	0	0	2	10	0	0
r_{16}	0	0	0	0	0	0	0	0	3	0	2	1	0	0	0	12	0
r_{17}	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	10

Figure 47 The paths overlapping table when trunc value = 7 and glimpse value = 40

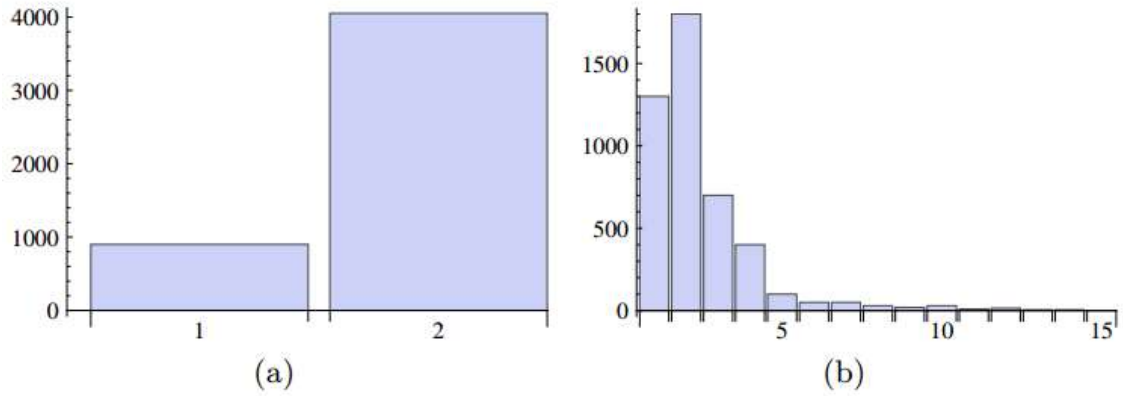


Figure 48 Histograms of the number of different origins for a same destination (a) and vice versa (b) in the restaurant paths. The value 1 in (a) shows that around 900 paths start from restaurant visited less than 2 times

These simple experiments allow us to conclude that the JRip rules we used may represent a distinguishing genomic trait of the users. These traits, paired with the good starting points suggested by the Entree web-service, allow to associate each people with her/his favorite restaurant without ambiguities. The meaningful of the genomic trait stands also in the restaurant selectivity. Apart from a few exceptions, restaurant receives people with at most 4 different <rule, starting point> characterizations.

7.5 User Experience Evaluation of the SILMS Recommender System

In this section we study the effects of two different requirement collection strategies on the perceived overall recommendation quality of the NETT-RS. In the first strategy users are not allowed to refine and change the requirements once chosen, while in the second strategy the system allows the users to modify the requirements (we refer to this strategy as backtracking). We run the study following the well established ResQue methodology for user-centric evaluation of RS.

Our experimental results indicate that backtracking has a strong positive impact on the perceived recommendation quality of the SILMS-RS.

The characteristics of a SILMS-RS closely match the ones proper of constraint based RS [70] , as the teacher specifies a set of requirements (in the form of rules and keywords) to which resources must adhere in order to be recommended. The multi-phased process allows the teacher to incrementally explore the resource space in order to find the most suitable ones for her/his course, in the vain of conversational RS [71] [72]. However, this interaction with the user required by the SILMS-RS entails several challenges. The teacher must be put within an interactive loop with the system, with the possibility to revise the rules and keywords previously specified. We refer to this feature as backtracking.

In this section, we study the effect of the backtracking feature on the SILMS-RS. We argue that providing a backtracking feature to the SILMS-RS strongly affects the perceived recommendation quality. In order to answer this research question, we set up a user-centric evaluation [73] of the NETT-RS following the ResQue methodology [74]. We compare two versions of the SILMS-RS (with and without backtracking) over many different user-centric quality dimensions [75]. Evidence gathered from this study substantiates our intuition: the presence of backtracking has a strong impact on many

different quality measures, such as control, perceived, ease of use and overall satisfaction.

7.5.1 Evaluating the Backtracking Feature

From the user interaction point of view we argue that the backtracking feature has a high impact on the overall perceived quality of the NETT-RS. We substantiate this claim with empirical evidence gathered from a user-centric evaluation of the NETT-RS. The remainder of this Section describes the experiment we conducted, starting from the research question and hypotheses, the experimental setting, and ending with the discussion of the experimental results.

7.5.2 The Backtracking Feature

The NETT-RS requires the teacher to go through all the three steps described above in order to finalize the design of a course. During each step the system provides the teacher with a set of automatically selected items, namely: rules, keywords or resources.

Figure 49 The resource selection step

The strong assumption we make on such a process is that the choices made by the teacher in one phase can potentially affect the result of the subsequent phases. For this reason we argue that allowing the teacher to go back and forth the phases, and possibly revising the selections, has a strong impact on the perceived quality of the resource suggestion in the final step (Figure 49). The need of such a backtracking feature was furthermore observed by alpha testers of the NETT-RS, which initially were not equipped with such feature.

7.5.3 Research Question and Hypotheses

Our question is rather simple and pragmatic:
Does providing a backtracking feature to teachers affect the perceived quality of the recommendation of the NETT System?
In order to provide an answer to this question, we evaluate the SILMS-RS and formulate the two following hypotheses:
H1: the possibility to revise the choices made during the course design process increases *the perceived user control* over the SILMS-RS.

H2: the possibility to revise the choices made during the course design process increases *the perceived overall quality* of the SILMS-RS.

The hypothesis **H1** focuses on a specific quality of the NETT-RS (i.e., the user control over the recommendation process), which is only one of the possible dimensions that contribute to the *perceived overall quality of the system* (**H2**).

7.5.4 Experimental Design

Two versions of the NETT-RS were evaluated: the first one without the backtracking feature enabled (i.e., NETT-RS) and the second one with backtracking (i.e., NETT-RS-b). As for testing our hypotheses, we adopted the ResQue methodology [74], which is a well-established technique for the user-centric evaluation of RSs. We selected 40 participants, mainly university professors, and asked them to design a course on Probability and Statistics, choosing from 1170 different learning resources. We selected such resources from the MIT Open-
CourseWare website [11]. The participants were equally partitioned into two disjoint subsets (20 + 20). Participants from the first subset were asked to design a course using NETT-RS, while participants from the second subset used NETT-RS-b. Finally, participants were presented with a questionnaire.

[11] http://ocw.mit.edu/index.htm

	Quality	Question
Q1	*recommendation accuracy*	The teaching material recommended to me match my interests
Q2	*recommendation novelty*	The recommender system helped me discover new teaching material
Q3	*recommendation diversity*	The items recommended to me show a great variety of options
Q4	*interface adequacy*	The layout and labels of the recommender interface are adequate
Q5	*explanation*	The recommender explains why the single teaching materials are recommended to me
Q6	*information sufficiency*	The information provided for the recommended teaching material is sufficient for me to take a decision
Q7	*interaction adequacy*	I found it easy to tell the system what I like/dislike
Q8	*perceived ease of use*	I became familiar with the recommender system very quickly
Q9	*control*	I feel in control of modifying my requests
Q10	*transparency*	I understood why the learning material was recommended to me
Q11	*perceived usefulness*	The recommender helped me find the ideal learning material
Q12	*overall satisfaction*	Overall, I am satisfied with the recommender
Q13	*confidence and trust*	The recommender can be trusted
Q14	*use intentions*	I will use this recommender again
Q15	*purchase intention*	I would adopt the learning materials recommended, given the opportunity

Figure 50 The adapted version of the ResQue questionnaire used in our study

7.5.5 The Adapted ResQue Questionnaire

The ResQue questionnaire [74] defines a wide set of user-centric quality metrics to evaluate the perceived qualities of RSs and to predict users' behavioral intentions as a result of these evaluations (Fig. 51). The original version of the questionnaire included 43 questions, evaluating 15 different qualities, such as recommendation accuracy or control. Participants' responses to each question are characterized by using a 5-point Likert scale from strongly disagree (1) to strongly agree (5). Two versions of the questionnaire have been proposed [74]: a longer version (43 questions) and a shorter version (15 questions). In our study we adopted the short version in order to reduce the cognitive load required to participants. A modified version of the questionnaire, tailored for a system that recommends learning resources, was presented to the participants. Table in Fig. 50 contains the adapted version of the questionnaire.

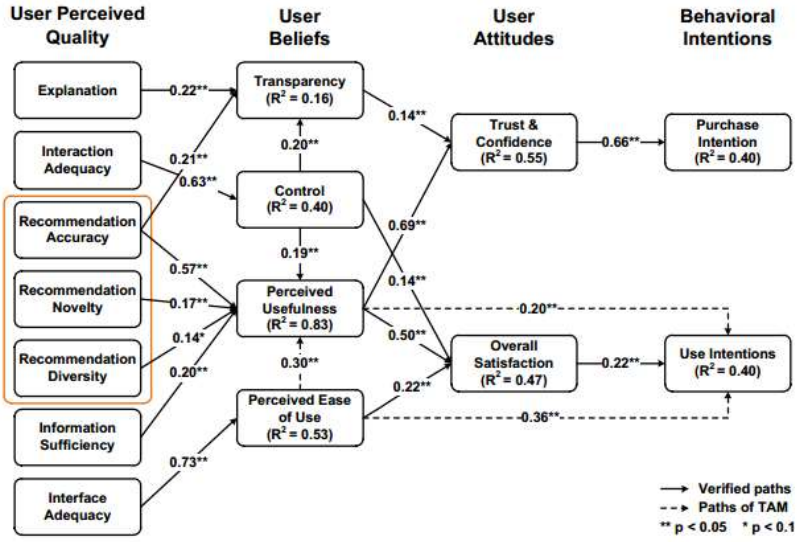


Figure 51 Structural model fit. Path significance: **p < 0.05, *p

7.5.6 Experimental Results and Discussion

Figure 52 reports the mean grades for all the issued questions. We got a Cronbach's α [76] equal to 0.919 and 0.887 for grades given by participants who evaluated the SILMS-RS and the SILMS-RS-b, respectively. Thus, we consider the questioned participants to be reliable. SILMS-RS-b achieves the most noticeable result on the control quality (Q9) showing that the presence of the backtracking lifts the mean judgment up from 1.30 to 4.45 (342% of improvement). The difference is significant with a p-value < 0:0001, providing strong experimental evidence for the hypothesis H1: the possibility to revise the choices made during the course design process increases the perceived user control over the SILMS-RS. As far as the overall quality is concerned (hypothesis H2) we observe strong significant improvements (p < 0:0001) in the perceived ease of use, perceived usefulness, overall satisfaction, confidence and trust, use intentions and purchase intention qualities. This evidence allows us to correlate the presence of the backtracking feature with a higher perceived overall quality of the SILMS-RS in terms of the above features.
The presence of the backtracking feature does not lead to a significant improvement of the recommendation accuracy. However, we observe significant improvements ($p \approx 0.012$ and $p \approx 0.002$) on recommendation novelty and recommendation diversity. Our interpretation is that enabling the users to go back and forth the steps allows them to better explore the resource space, thus leading to novel and diverse recommendations.

Finally, we observe that the presence of the backtracking feature has no significant impact on the interface adequacy, explanation and transparency qualities. We furthermore observe that participants assigned a relatively low grade, especially for the interface adequacy. Such results may come from the difficulty to understand the meaning of rules (Section 7.3 and Fig. 43) presented by the SILMS-RS. We consider it as a stimulus for a future improvement of the system.

Question	Quality	NETT-RS	NETT-RS-b	*p*-value
Q1	*recommendation accuracy*	3.80	3.95	0.481
Q2	*recommendation novelty*	3.50	**4.05**	0.012
Q3	*recommendation diversity*	3.50	**4.10**	0.002
Q4	*interface adequacy*	2.90	3.30	0.088
Q5	*explanation*	3.40	3.60	0.162
Q6	*information sufficiency*	3.35	**4.25**	< 0.0006
Q7	*interaction adequacy*	3.10	**3.60**	< 0.002
Q8	*perceived ease of use*	3.45	**4.60**	< 0.0001
Q9	*control*	1.30	**4.45**	< 0.0001
Q10	*transparency*	3.45	3.75	0.110
Q11	*perceived usefulness*	3.00	**4.00**	< 0.0004
Q12	*overall satisfaction*	2.80	**3.90**	< 0.0001
Q13	*confidence and trust*	3.15	**3.80**	< 0.001
Q14	*use intentions*	2.70	**3.70**	< 0.0001
Q15	*purchase intention*	3.30	**4.10**	< 0.0001

Figure 52 Mean grades to questionnaire's questions. p-values are computed by means of a two-tailed t-test. Statistically significant improvements are marked in bold

8. CONCLUSIONS

After two years of work jointly with European teams the SILMS platform, hosted by the project NETT, is almost fully running. We have numbers for registered users coming from all the world. Of the 2680 users that registered on the platform, 1915 ones have completed their profile by adding further details and confirming via e-mail the creation of their profile The spectrum of user nationality is very wide: 249 countries with obvious peaks in correspondence of the project partner countries. Coming to the sole registered user, the spectrum remains the same. The correctness of the DB population, hence the genuine interest on the platform is witnessed by the fact that:

- The registrations number per day is homogeneous enough (see next graph), with a concentration around the end of 2014 in occasion of the final NETT conference (see Figure 53)

Figure 53 Course of the daily registration numbers

- with a honest activity trend (an endogenous peak on September/October 20113 – see Figure 54), and

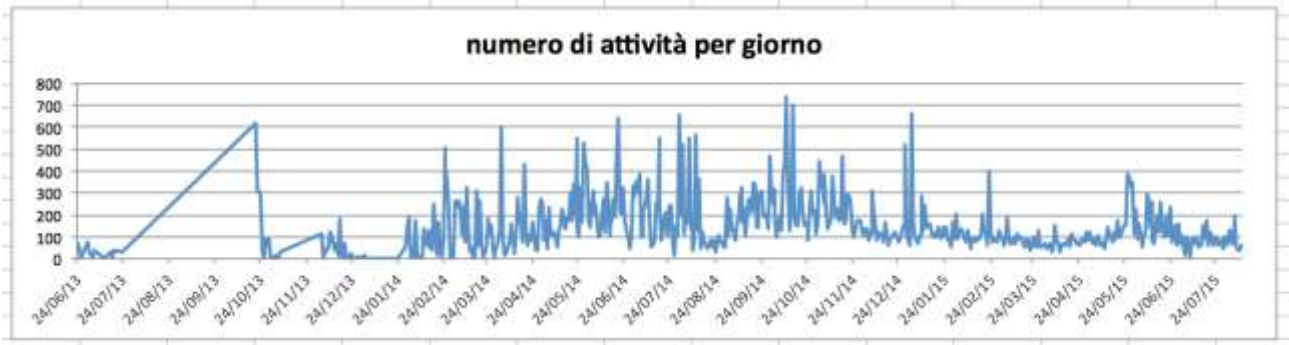


Figure 54 Course of daily activities' numbers

- a honest distribution of the overall 48.348 activities of the guest users, mainly "giving a look", as shown in the following pie graph (see Figure 55)

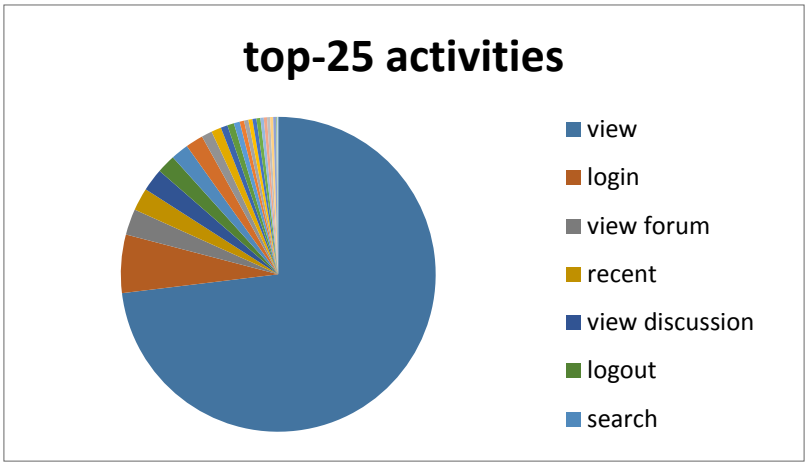


Figure 55 Distribution of the top 25 activities carried out by the platform users. The aside list reports the top-6 ones

Though a fully efficacy of the platform is tightly connected to the existence of a very high population of user – like in all social platform of similar characteristics, nevertheless we may ascribe our relative success, at least as for the gathered interest, to the key features of the services it offers:

- high quality contents – ensured by the authoring mechanism
- open contribution on the part of the users – though with proper filtering mechanisms
- concreteness of the services – nothing else than what requested
- adaptiveness of the answers to the real preferences of the user – a feature that come to be irrevocable in modern web-services.

As per usual in research and advanced development, one may never say "and that's all folks", since each result can and must be improved with the practice. I hope this work can prove suitable for next developments, especially in the parts concerning the recommender system – a facility that is expected by the most part of the today web-services, and the user experience – in a concrete way, hence beyond the attractiveness of any emotional avatar.

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