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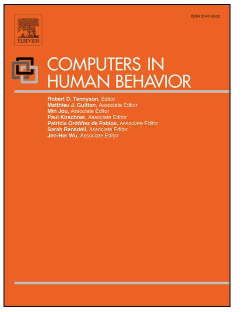

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MoodleREC: a Recommendation System for Creating Courses Using the Moodle e-Learning Platform

Abstract

The field of education has never been indifferent to the new technologies, and eventually to the Internet. Technology-Enhanced Learning, progressively, has grown to be the area for research and practice on the application of information and communication technologies to teaching and learning. In particular for the teaching activity, the numerous standard compliant Learning Object Repositories available via the Internet, and Open Educational Resources repositories, provide formidable support to teachers when they need to develop a course that can also make use of already available learning materials. The search and selection of Learning Objects, however, can be an inherently complex operation involving accessing various repositories, each potentially involving different software tools, and different organization and specification formats for the learning resources. This complexity may hinder the very success of an e-learning course. Cross-repository aggregators, i.e., systems that can roam through different repositories to satisfy the user's/teacher's query, can help to reduce such complexity, although problems of course delivery may remain. This paper proposes a hybrid recommender system, *MoodleRec* , implemented as a plug-in of the Moodle Learning Management System. *MoodleRec* can sort through a set of supported standard compliant Learning Object Repositories, and suggest a ranked list of Learning Objects following a simple keyword-based query. The various recommendation strategies operate on two levels. First, a ranked list of Learning Objects is created, ordered by their correspondence to the query, and by their quality, as indicated by the repository of origin. Social generated features are then used to show the teacher how the Learning Objects listed have been exploited in other courses. A *real life* experimental study is also presented, and the validity of the *MoodleRec* approach discussed.

Keywords: Recommender Systems, e-Learning, Learning Object, Learning Object Repository

1. Introduction

The field of education has never been indifferent to the new technologies, and eventually to the opportunities offered by Internet and the World Wide Web. Technology-Enhanced Learning (TEL) encompasses, in principle, the use of both analogical and digital technologies to support education. TEL, in particular, has grown to be a research and practice area for the application of

Information and Communication Technologies (ICT) to teaching and learning. Basically in TEL, training methodologies are based on digital technologies, emphasizing the interactivity of the learning process, the active experimentation of knowledge, and the common construction of knowledge (Daniela et al., 2019) (Kirkwood & Price, 2014). These methodologies turn out to expand and enrich, by integration, the potential of both the classic learning process, and the software tools used in Internet.

In this context, the Web offers exceptional opportunities. An enormous wealth of learning resources and technologies can be made available in a relatively simple way: for teachers, the Web is a rich field, where they can find useful educational materials suitable for supplementing or creating a course. For learners the opportunity to take advantage of continuous learning through the use of free didactic materials and interactions with peers, using a suitable technological environment that enhances their growth. Over time, the role of the teacher itself has changed, also due to the effects of this increased availability of teaching and learning materials. Particularly with e-learning, teachers can act as course constructors and facilitators, guiding the learner through their educational experiences. In addition, the variety of learning resources available on the Web, and the flexibility of modern Learning Management Systems (LMSs), can often allow the teacher to provide a certain degree of personalization with regard to the learning experience.

All the above features are of great usefulness in the framework of Higher Education (HE) as they may allow distant, or hardly meeting, teachers to share methodological viewpoints, and learning contents, empowering them through digital technologies. This may reveal crucial in allowing a teacher to expand the environment where (s)he is confronting with new methodologies, and getting inspiration (and contents). These are also the same advantages that can be significant for the teachers in Intermediate Education (IE - such as High School): these "users" of digital and Internet technologies, may profit of network based sharing of learning resources and ideas as well as teachers in HE, and sometimes they are even more eager to exploit such possibilities for their personal and professional growth.

In spite of all the advantages mentioned so far, though, the process of preparing a new online course is extremely complex and time-consuming In HE as well in IE. It is a process that involves the teacher in several tasks such as: i) creating the concept map; ii) preparing and/or retrieving learning materials to include in the course; iii) creating a didactic storyboard; iv) preparing the course delivery via the adopted LMS. For an online course to be effective, one of the stages in which the teacher's input is most important is the one related to retrieval, analysis and selection of learning materials. The search and retrieval of such materials is usually a long and laborious process, in which the resource, if found, has to be carefully appraised to determine its quality and suitability for the course at hand. Moreover, materials on the Web might often be unsuitable for educational purposes, or turn up a range of potential choices that is so vast that the teacher can become confused or frustrated. As a result, technology, e.g. Web-based systems that can support and speed up this process, is of great importance to the teacher and to the learner.

1.1. *Looking for Learning Objects*

Standard compliant Learning Objects (LOs) are a well-established source of teaching materials. Each LO is defined according to a formal specification, based on the use of different sets of *metadata*. Different standards characterize different sets of metadata , such as in IEEE LOM (Learning Object Metadata) (LOM, 2018), MLR (MLR, 2018), and DublinCore (DublinCore, 2018). LOs are usually made available on the Web through Learning Object Repositories (LORs), which gather LOs that are defined according to a given standard. The importance of LORs for users in general (teachers, but also students) lies in the fact that they allow for the searching and retrieval of their LOs by means of suitable software interfaces, based, in turn, on the standard used for the stored LOs. Merlot (Merlot, 2018) offers more than 82,000 LOs, 22,000 bookmark collections and 884 courses. Cnx (Cnx, 2018) allows users to explore more than 2,000 books and over 32,000 small "knowledge chunks" in various subject areas (Arts, Business, Humanities, Mathematics and Statistics, Science and Technology and Social Science). Ariadne (Duval et al., 2001; Ternier et al., 2009) is the celebrated result of a long-standing European project, and can provide access to as many as 260,000 learning resources. Wisc-online (Wisc, 2018) has over 2,500 learning objects.

While there are many other LORs, those mentioned above are available for making integrated searches through the *MoodleRec* module that is presented here.

When a teacher searches for suitable LOs while creating a new, or improving an old, course, LORs provide potentially invaluable assistance. However, a teacher has to deal with inherently complex factors when visiting a LOR. First, there is a multitude of LORs available on the Internet, each with its own, typically interactive, search tools. Moreover, the teacher needs to visit as many of them as possible in order to make the search process more complete. In addition, the response to a teacher's query might turn up a huge number of LOs, presenting the receiver with the difficult task of having to analyze them all before selecting the right one.

1.2. *Our proposal:* MoodleRec

This section describes an approach to counter the aforementioned complexity, allowing a teacher to search for multiple LORs at the same time with a query composed of keywords, while working on her/his course in a Moodle (Moodle, 2018) LMS instance to build a new course . Moodle is the most popular Learning Management System in the world, with over 80 million users in 222 countries. The system we have developed is configured as a Moodle *plug-in*, that is, as a module that can add a learning *activity* to a course. This module operates as a recommender system embedded in Moodle. It allows the teacher to:

- send a query;

- receive a ranked list of LOs from the various LORs;
- examine various information about the LOs in the list, such as their use in other courses, and how similar teachers in the same LMS have used them;
- select one or more LOs from the list for inclusion in the course that the teacher is editing.

The fact that you can work exclusively in the LMS without having to go and visit individual LORs, as well as having the chance to add the selected LO(s) to the course directly, is a highly practical benefit and makes the teacher's work much simpler. Moreover, the recommended data accompanying the retrieved LOs make it quicker for the teacher to make an informed choice. This module privileges the retrieval of materials on the basis of the following criteria:

- the correspondence between LO metadata and the keywords of the query,
- the rating awarded to the LO in the LOR of origin (if available),
- the actual use of the LO in courses created by other teachers working in the same LMS.

The overall service provided by the module is thus twofold: on the one hand it helps the individual teacher, and on the other hand it contributes to the creation and updating of a community of teachers operating in the same LMS. The individual teacher can glean ideas about the usefulness and management of LOs, simply by looking at how other colleagues have used and organized such materials in their courses.

The module presented here is limited to operating in a single instance of Moodle. However, the architecture described can clearly be extended to connect various instances of the same LMS, so as to capitalize on the experience of many more teachers than those just working in one single instance.

1.3. MoodleRec *experimentation*

A previous version of our approach was in (Deleted, 2015) and a preliminary experimental case study was later discussed in (Deleted, 2017).

The present proposal focuses on the hybrid recommendation that is at the heart of the module. What is more, we shall also present and discuss an *online* experimentation and evaluation of the system. The main goal is thus to check the general usefulness of the proposed approach.

Consequently, the main research question is:

RQ1: Does the Recommending system help teachers to create a new course?
Other goals regard checking system usability from the point of view of human-computer interaction, and gauging user satisfaction with the experience as a whole. The following two research questions were therefore added:

RQ2: Is the user satisfied by her/his experience in using the system?
and

RQ3: Was the system considered usable by the sample that used it?

During the experimentation phase, a sample of higher education and university teachers used Moodle and *MoodleRec* to create courses. Subsequently, an evaluation was carried out by analyzing certain standard metrics and administering two distinct questionnaires based on 5-point Likert scale questions.

Satisfactory results were obtained and expected difficulties were confirmed: *RQ1* basically received a positive response, along with *RQ3*. Users were satisfied with the use of the recommending engine, and in particular with the effectiveness of the *MoodleRec* approach. The answers to the questionnaire relating to *RQ2* show that users were satisfied when using the module for a (comparatively) good length of time, although only 46% actually used the social feature of the approach.

1.4. Structure of the paper

In the following section, we will present some related work in the areas of LOs, LORs and LOR interoperability, with particular focus on support provided for the teacher. In Sec. 3 the design and features of the *MoodleRec* Moodle extension are briefly described, focusing on the various steps/phases of the recommendation process. Sec. 4 presents the evaluation of the system and its results, and also provides a discussion of the findings. The final section considers the limitations of the present work, and potential further developments and experimentation regarding the *MoodleRec* approach.

2. Context and Related Work

The research work, and practical use, of TEL in education, has stimulated a great debate about the use of technology in education, and in particular on its use in HE. The main focus, in such debate, is on how TEL can enhance teaching and learning activities and processes, turning them into levers of sustainable socio-economic growth and development (Daniela et al., 2018). In this work we propose a web-based system deemed to help teachers build a new course by receiving recommendations from the system, about suitable LOs available in LORs, and by being shown how such LOs are used in similar pre-existing courses. This provides technological support to teaching during the course construction. Here the "technology" is related to the management of LOs, to the software services offered by LORs, and to the techniques and implementations of recommending techniques. So in this section we provide a description of literature about LOs and LORs, and an analysis of the ways LOs are recommended in other systems, compared with ours. We conclude this section by describing how recommendation of LOs from multiple LORs is provided in literature, again to help compare our solution.

2.1. Learning Objects

The concept of Learning Object (LO) has been defined in various, and occasionally contrasting, ways (Sinclair et al., 2013). According to IEEE Computer Society (2002), *"A LO is any entity, digital or non-digital, that may be used for* *learning, education or training"*, while in Wiley (2001a) we read that *"A LO is any digital resource that can be reused to support learning"*.

Further definitions have been proposed for LOs, with reference to resources capable of supporting learning, either generically or by introducing specific constraints such as independence, self-containment, aggregability, granularity, reusability and customizability (Rehak & Mason, 2003; Wiley, 2000, 2001a; Beck, 2010).

The granularity of a LO can range from being an atomic *asset* – such as an image or a text where it is a learning resource used alongside others to create a lecture – to being a complete lecture or even sequence of lectures.

Reusability is not always included in all these definitions, as it leads, in the opinion of many, to an inherent contradiction (Wiley, 2001b; Sinclair et al., 2013) often associated with the context dependency of the learning content of a LO. The contradiction lies in the fact that *the more context-laden* (Wiley, 2001a) a LO is, the more effective it might be in its own learning context, and the more difficult it becomes to integrate it in a different context. On the other hand, the more generic a LO is, the more extensive the work will be for a teacher in tailoring it to her/his own learning context.

In spite of the various interpretations, and critiques that exist regarding the concept of LO itself (Ochoa, 2005), the number of LOs on the internet, available through LORs, has been increasing (Tarus et al., 2017; Mourino-Garcia et al., 2018). At the same time, the problem of determining the usefulness of a LO has to be left to the final user, i.e., the teacher. It is she/he who wants to see what is available on a topic of interest, what can be taken as example and what might be chosen, with or without modification, for inclusion in a course being developed.

From the teacher's perspective, there is a great wealth of learning resources, defined by certain standards and available through LORs. The teacher is also the ultimate judge as far as the appropriate application of a LO to the specific context of a course is concerned. A major main issue is thus the *discoverability* of the resources, or, in other words, the support offered in the retrieval of LOs based on a teacher's query. This should be performed in as short a time as possible on as many LORs as possible (Sinclair et al., 2013).

The present proposal is in line with these parameters, with the added feature of allowing the teacher to work in her/his LMS environment, without having to surf the Web throughout the course operations (i.e., querying LORs simultaneously, analyzing recommendations, selecting LOs, and including them in the course).

2.1.1. Learning Object Repositories

Nowadays LORs are collections of digital resources, created with the purpose of being shared for educational purposes. Not all resources strictly follow the LO definition provided earlier (we might also find books or entire courses). However, for the sake of simplicity, we will henceforth refer to any resource from a LOR as a LO. LOs are specified by means of standard metadata, and LORs use such metadata to permit cataloguing and searching.

As mentioned above, there are many LORs, digital libraries of LOs or initiatives to aggregate LORs that are available on the internet (Roy et al., 2010). Some examples are: OERCommons (OERCommons, 2018), MERLOT (Merlot, 2018), Open Stax CNX - Connexions (Cnx, 2018), WISC-ONLINE (Wisc, 2018), iLumina (Ilumina, 2018), ARIADNE (Duval et al., 2001; Ternier et al., 2009), MACE (MACE, 2018), ELENA (Dolog et al., 2004), LRE-MELT (LRE-MELT, 2018) and PROLEARN (Wolpers & Grohmann, 2005).

The management and sharing of LOs through LORs is the subject of an ongoing debate (Ochoa, 2005; Sinclair et al., 2013) with the focus on *issues* and *promises*.

One well-known issue regards the problem of *discoverability*, which is common to all web resources, and appears to be particularly more complex for LOs. Another issue concerns the occurrence of lost links and disappearing resources. Undoubtedly this does not facilitate the work of a teacher, and it requires perseverance when making searches. A further issue can be the misconception that searching repositories for LOs is a means for the teacher to develop, or supplement, a course without any effort. On the contrary, LOs should be searched with the aim of enriching and varying course content - content with which the teacher is already familiar (Sinclair et al., 2013).

The promises are based on the fact that, in spite of the aforementioned issues, LORs are growing in size and in number (Mourino-Garcia et al., 2018; Tarus et al., 2017). Two general features, which should render LORs more usable and trustworthy, are in continuous development: 1) a better user interface (allowing for local searches in the repository) and 2) an increasingly collaborative aspect (e.g., peer-review and the sharing of feedback on LOs). The latter, in particular, helps to make the LOR an expression of the educational community which uses it.

2.2. LO Recommendations

Recommender systems working on LORs are usually classified according to the similarity principles upon which they are based (Adomavicius & Tuzhilin, 2005; Cechinel et al., 2013). *Content based* systems compute the similarity between LOs, so as to provide the user with a selection of LOs corresponding to the user query or to the user's previous choices. Systems using *Collaborative Filtering* work on the idea of determining the usefulness that a resource may have for a user based on the similarity of the user's decisions (e.g., the selection of a LO) with other users' decisions. *Hybrid systems* use combinations of the aforementioned approaches. In fact, the system presented here belongs to this type.

2.2.1. The MoodleRec *approach*

Since this section will compare some of the approaches found in the literature with our own, it is appropriate to commence with a brief outline of the main characteristics of *MoodleRec* .

- The approach is focused on support.

- Through Moodle, the recommendation engine retrieves LOs from most popular LORs, and aggregates them in a list of recommendations ordered by rank.

- The hybrid recommendation system matches a content-based similarity evaluation on LOs with a collaborative filtering approach. The two techniques are not integrated; rather, they provide the teacher with two sources of recommendations, leaving her/him to choose the LOs from them.

- The collaborative filtering approach is based on a teacher model, defined as the *history* of the LOs selected and used by the teacher in her/his courses.

- A teacher interested in a LO is supported by the system and may thus examine the courses of other teachers in which the LO was used. This allows the teacher to assess the previous context of use of the LO, and helps her/him to decide whether to adopt it or not.

In particular, the issue of search and retrieval in *MoodleRec* is managed by means of simple query expansion: the teacher's query is modified to include additional terms and to make several versions out of it. Each LOR thus has a query tailored to its metadata standard and search engine. The list of retrieved LOs is ordered in correspondence with the query's keywords, and with the ranking provided by the LOR it is from (if available). Further help is provided by teachers, i.e., from implicit appraisal based on the fact that a certain LO that has been profitably used in other courses by other users in the LMS.

2.2.2. LO recommendations from LORs

In this area, the majority of proposals in the literature cover students' learning needs (Manouselis et al., 2011), while teacher support is often a minor concern with regard to the software system.

In Dorca et al. (2017) an approach to retrieving LOs is presented and a recommendation is given; the LOs retrieved are clustered according to the student's Learning Style (LS). Indeed, clustering algorithms are used to reorganize a LOR. An ontology encapsulates the pedagogical characteristics of the LOs, in so far as they are specified in the metadata. A personalized recommendation of learning content is thus obtained by correlating metadata with the student's Felder-Silverman LS model.

The paper advocates the use of Machine Learning and Ontologies as technical bases and support to Data Mining respectively. A Machine Learning / Ontology based approach has also been adopted in other cases in order to reduce the taxonomies of different LORs to a single one, or to represent them as ontologies and perform ontology mapping (Kawase et al., 2013; Shvaiko, 2013). This smart approach is currently under development, so may still suffer from the problem of mapping metadata items to taxonomies, or to ontologies, where such items are not defined and cannot be defined in other terms.

Rivera et al. (2018) performed a systematic study of the use and effect of recommender systems in education. The main aims of the study were to investigate the distribution of disciplinary areas covered by the systems and the repositories where such systems work, and to identify the gaps in current research regarding the approaches used to generate recommendations. Among the results of this study was the observation that almost half of the recommending algorithms are based on hybrid approaches, while about 30% of the systems exclusively use a collaborative filtering technique. Other interesting conclusions regard the delivery platform on which such systems work: in the majority of cases (52%) the system is part of a web application and can be used on-line. In 2% of cases the application is native mobile. As to the rest, most are systems only described at the conceptual model level. No data are presented with regard to integration in an LMS, that is, the environment where the teacher is supposed to work primarily when managing on-line courses.

2.3. Support for the teacher in the search and retrieval of LOs

Here we report on systems that support the search and recommendation of LOs that are retrieved by querying several LORs at the same time. Moreover, we are interested in how such systems are integrated in an LMS in order to provide their services directly in the context where the teacher is working.

Such integration is, however, hard to find, *discoverability* probably being the issue that dominates research efforts in this field.

Wang et al. (2007) proposes an adaptive personalized recommendation model which advocates SCORM compliant LOs from internet repositories based on semantic discovery, preference-based and correlation-based approaches. In this way the system infers learner preferences and predicts LO suitability on the basis of the uses that similar learners made of the LO. In this case the system does not provide a LMS that supports the whole course plan. Moreover, the system is largely learner oriented.

Various approaches to LO search and retrieval are considered in Azambuja Silveira et al. (2015), and a multi-agent system is presented that can index, retrieve and recommend LOs from heterogeneous LORs. The system provides the user with recommendations tailored to the user profile. The user's search query is managed through the use of ontology. The protocol is based on a query, made by the user, which is then expanded. The final keyword expansion is thus obtained, and the expanded query can be used for a web search carried out by each agent on their own specific LOR. The description of the system focuses mainly on the technological possibilities and choices for the communication between agents and repositories. The implementation of the system is described as ongoing, while two domain ontologies are available on medical topics and information security. Integration into the LMS Moodle is also reported as ongoing. From the perspective of the approach presented in this paper, we see that there are great similarities in the idea of searching and indexing different repositories by means of dedicated agents. The personalization of the recommendations is content-based given that links between the user profile and the content of the LOs are considered. In our case we adopt a hybrid approach with an explicit focus on personalizing the recommendations based on the teaching similarities between users.

Bozo et al. (2010) proposes a personalized recommender approach, focused on teachers, i.e., for LO retrieval geared towards the teacher's context model. They use metadata extracts from LOs to annotate both content and *teacher context* and use a hybrid approach based on collaborative filtering and a content-based recommendation.

DOOR (DOOR, 2009) (Digital Open Object Repository) is a free learning object repository implementing IMS (IMS, 2018) metadata, and so is compliant with IEEE LOM (LOM, 2018). It is devised as an Open Source module for Moodle to be used for "producing, storing and reusing digital learning contents". The LOs are produced by DOOR to be compliant with IMS Metadata 1.2.1 and Content Package 1.1.3. They can be searched for and added to a course. However, DOOR does not provide a recommendation engine.

eNOSHA is a free and open source LOR that makes resident LOs available and provides links to LOs stored in other repositories. LOs are divided into four granularity levels, from "atoms" (digital assets such as text or images) to "full course". The focus of interest here is integrating eNOSHA with the Moodle LMS (Mozelius et al., 2011). This is implemented in such a way that a user authenticated in Moodle is also automatically authenticated in the LOR. There can be multiple instances of eNOSHA running in parallel with different contents. The user can select which LOR to connect to, and perform LO searches there. A selected LO from those retrieved can be imported to the teacher's Moodle account and course.

A *metadata harvesting* approach is provided in MACE, Metadata for Architectural Contents in Europe (Stefaner et al., 2007), where the resources offered by various repositories can be searched in order to help students find suitable LOs. The central MACE database stores metadata about the available LOs, by downloading (*harvesting*) from the LORs. The metadata are LOM standard compliant, with some extensions supporting the overall architecture. Such metadata are used to construct a representation vector for each LO, and the similarity between two LOs is computed based on these vectors. Usage data are collected for the LOs. The cosine similarity measure is used to determine likeness, based on the aforementioned usage data. This architecture allows for the application of approaches for the recommendation of LOs from LORs based on the links between the LOs (i.e., the correspondence of usage data between two LOs) rather than on the relations between users and LOs (Niemann et al., 2011). MACE, and the recommendation approaches it fosters, is centered on the individual user interested in LOs rather than on the teacher, so its recommendations are based on a generalized concept of LO usage. It is in this specific respect that our own approach differs. Indeed, we intend to demonstrate to the teacher the pedagogical uses that derive from LOs: the teacher can be stimulated by such examples as well as by their similarities with other teachers and uses of LOs.

GLOBE (Global Learning Objects Brokered Exchange) is a search engine that operates on federated LORs (Gasevic et al., 2007). This system allows for repositories to be interrogated through a Simple Query Interface, SQI (Ternier & Duval, 2006), web search query. This was an attempt to standardize interoperability through LMSs, by making it possible to query repositories based on different metadata schemas. A Moodle plug-in was developed to implement this project (Duval et al., 2007), allowing users to retrieve and store a LO as a local object from the ARIADNE repository. Analogous projects were developed over time (Fertalj et al., 2010) at a conceptual level and, in some cases, at the implementation level. An example is CORDRA (Content Object Repository Discovery and Registration Architecture), dedicated to SCORM compliant repositories (Shih et al., 2007).

Over time, all such initiatives have enjoyed varying degrees of implementation, but have also suffered from limitations. At times this was due to the range of LORs that could be queried, and other times to the fact that everything could happen only outside the LMS in which the teacher was operating, so any real, operational integration with LMSs was lacking. To conclude this section, it seems clear that the various features proposed in *MoodleRec* are also present in other systems described in the literature. Any system for the search and retrieval of LOs offers a comprehensive query interface, and the query can be managed by different techniques in different systems, but still with the aim of providing a list of results. Again, such a list can be the outcome of different recommending techniques, although the recommendation feature is not present in all the systems we investigated. Moreover, the integration with a LMS is indeed available in a smaller subset of the studies cited above. Nevertheless, a direct interest in supporting the work of the teacher is not a criterion often found in the systems we described. MoodleRec offers all the features mentioned above in a comprehensive and integrated approach.

3. The *MoodleRec* System

MoodleRec is a software module (*plug-in*) extending the Moodle LMS. Moodle is widely adopted in HE and IE institutions, and successfully used for its quality and extendability.

MoodleRec was first presented in (Deleted, 2017) and illustrated here in Fig. 1. It allows the teacher to query LORs by means of keywords that express the topics or concepts the teacher wishes to find in a LO. The query is transmitted to an external crawler that searches for the keywords in the selected LORs and performs an initial recommendation phase (*content filtering*), providing the user with a ranked list of LOs as output. The rank is also based on the quality evaluation provided for the LOs by the LORs where they are stored (limited to those LORs that have such a feature). The second phase of recommendation (*collaborative filtering*) also includes some social derived recommendation aspects. In particular, the system examines a given LO and shows where in the LMS other courses, and other teachers, are using it. In this phase, the LOs in the ranked list are sorted based on the *similarity* with the teachers that use that particular LO, that is, on the extent to which the choice of LOs correspond (Deleted, 2017). Moreover, the teacher can see the contexts in which other teachers have used the same LO. By context, we mean the LOs that frame the LO in question in the various courses where it is found. The range of such contexts, i.e., the distance of the surrounding LOs from the LO under investigation, can be personalized by the teacher. The default setting for such distance is the Moodle *section/argument* of the course, before and after the one in which the LO appears. The information provided by the use of the LO, and by the context of such usage, is important as it can provide the teacher with a better understanding of the LO that is based on how much other teachers use the LO in their teaching, and who these teachers are.

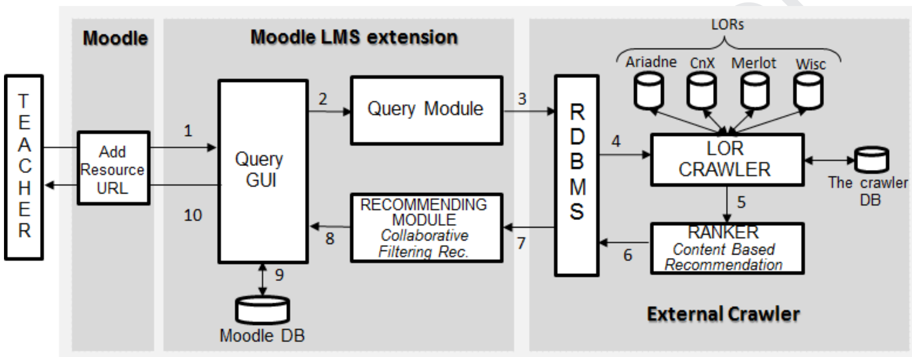


Figure 1: The functional schema of the system. Launching add url, the user accesses the Query GUI (1); the Query Module receives the query (2) and sends it to the external RDBMS (3) that transmits it (4) to the Crawler which extracts the LOs from the online repositories and sends them (5) to the Ranker. This combines the information retrieved by the Crawler with the Tf-Ifd measure to give a normalized score for the selected materials and sends the LOs that are assessed as relevant, for query to the RDBMS (6). The Recommending Module receives the retrieved LOs from the external service output (7) and indicates the environment through which these LOs can be managed. The selected LOs are then managed in the GUI (8) that interacts with the Moodle DB (9) providing further information for the recommender system. Through the GUI, the teacher obtains the selected LOs for her/his course (10).

Once the teacher has selected the LO, she/he can import it directly into the Moodle course by selecting the *import* button. In this way, the link to that material (not the material itself) will be imported into the course. We will now turn our attention to the description of the two recommendation steps.

3.1. The Recommendation Engine

The recommendation engine operates at different stages of the retrieval process. In the first phase of *content-based filtering*, each retrieved LO has two main indicators that can be used for the recommendation: the Tf-Idf score and the number of occurrences of the LO in the courses present in the LMS. In the second phase, the social-derived characteristics of the retrieved LOs are exploited. Namely, the course contexts of each LO usage can be accessed for inspection, ordered according to the perceived similarity between teachers.

3.1.1. Content filtering

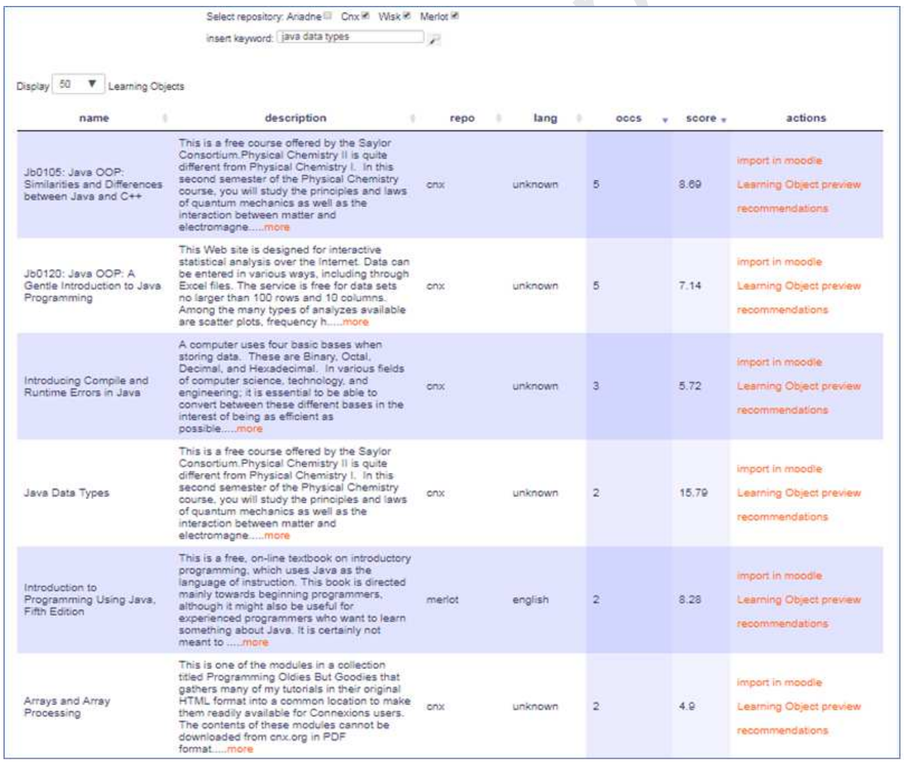
For each retrieved LO the Tf-Idf weighting scheme is used to determine a normalized score for how the information gathered by the crawler for the LO corresponds to the terms (keywords) in the query.

Another score for the retrieved LO regards the number of occurrences of the LO in courses managed in the LMS.

The list of retrieved LOs can be ordered according to these two scores, giving rise to two different recommendation rankings.

Further information provided by the list of retrieved LOs concerns the language of the LO (if this information is available through the metadata supported by the LOR of origin) and an indication of the repository where the LO is stored. An ordering of the list is also possible for these two features.

Fig. 2 and Fig. 3 show the first recommendation results based on the query "Java data types".



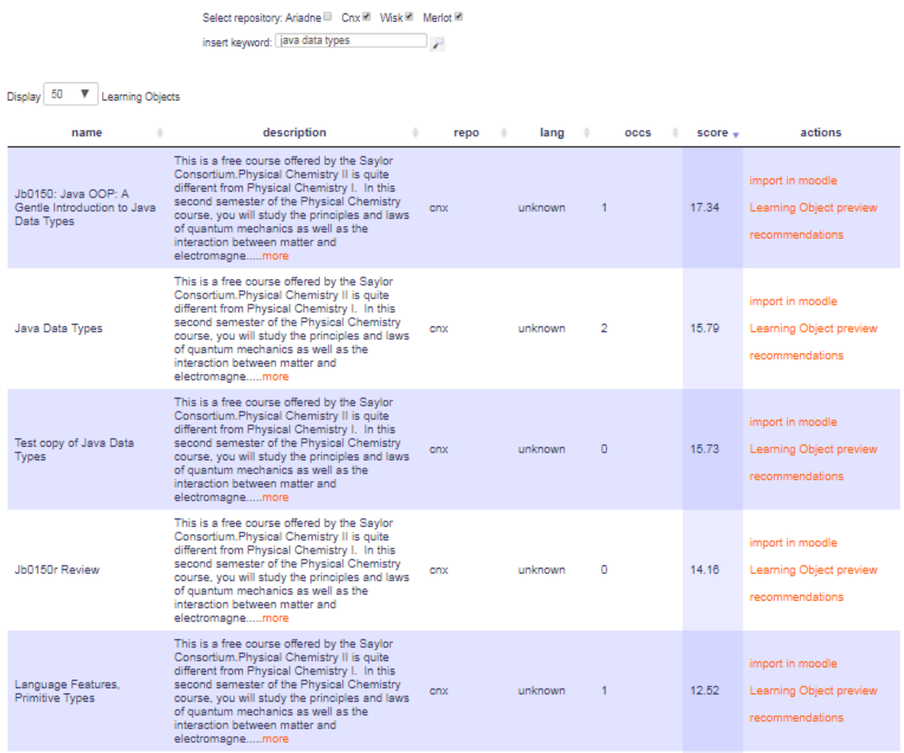
Select repository: Ariadne Cnx Wisk Merlot
insert keyword: java data types
Display 50 Learning Objects

name	description	repo	lang	occs	score	actions
Jb0105: Java OOP: Similarities and Differences between Java and C++	This is a free course offered by the Saylor Consortium.Physical Chemistry II is quite different from Physical Chemistry I. In this second semester of the Physical Chemistry course, you will study the principles and laws of quantum mechanics as well as the interaction between matter and electromagne.....more	cnx	unknown	5	8.69	import in moodle Learning Object preview recommendations
Jb0120: Java OOP: A Gentle Introduction to Java Programming	This Web site is designed for interactive statistical analysis over the Internet. Data can be entered in various ways, including through Excel files. The service is free for data sets no larger than 100 rows and 10 columns. Among the many types of analyzes available are scatter plots, frequency h.....more	cnx	unknown	5	7.14	import in moodle Learning Object preview recommendations
Introducing Compile and Runtime Errors in Java	A computer uses four basic bases when storing data. These are Binary, Octal, Decimal, and Hexadecimal. In various fields of computer science, technology, and engineering; it is essential to be able to convert between these different bases in the interest of being as efficient as possible.....more	cnx	unknown	3	5.72	import in moodle Learning Object preview recommendations
Java Data Types	This is a free course offered by the Saylor Consortium.Physical Chemistry II is quite different from Physical Chemistry I. In this second semester of the Physical Chemistry course, you will study the principles and laws of quantum mechanics as well as the interaction between matter and electromagne.....more	cnx	unknown	2	15.79	import in moodle Learning Object preview recommendations
Introduction to Programming Using Java, Fifth Edition	This is a free, on-line textbook on introductory programming, which uses Java as the language of instruction. This book is directed mainly towards beginning programmers, although it might also be useful for experienced programmers who want to learn something about Java. It is certainly not meant to .....more	merlot	english	2	8.28	import in moodle Learning Object preview recommendations
Arrays and Array Processing	This is one of the modules in a collection titled Programming Oldies But Goodies that gathers many of my tutorials in their original HTML format into a common location to make them readily available for Connexions users. The contents of these modules cannot be downloaded from cnx.org in PDF format.....more	cnx	unknown	2	4.9	import in moodle Learning Object preview recommendations

Figure 2: Some of the retrieved LOs based on the query "Java data types", ordered by number of occurrences (*occs* column).

3.1.2. Collaborative Filtering

For each of the retrieved LOs, the corresponding recommendation consists of the visualization of information relating to the usage of the LO in other courses



Select repository: Ariadne ☐ Cnx ☑ Wisk ☑ Merlot ☑

insert keyword: java data types

Display 50 Learning Objects

name	description	repo	lang	occs	score	actions
Jb0150: Java OOP: A Gentle Introduction to Java Data Types	This is a free course offered by the Saylor Consortium.Physical Chemistry II is quite different from Physical Chemistry I. In this second semester of the Physical Chemistry course, you will study the principles and laws of quantum mechanics as well as the interaction between matter and electromagne.....more	cnx	unknown	1	17.34	import in moodle Learning Object preview recommendations
Java Data Types	This is a free course offered by the Saylor Consortium.Physical Chemistry II is quite different from Physical Chemistry I. In this second semester of the Physical Chemistry course, you will study the principles and laws of quantum mechanics as well as the interaction between matter and electromagne.....more	cnx	unknown	2	15.79	import in moodle Learning Object preview recommendations
Test copy of Java Data Types	This is a free course offered by the Saylor Consortium.Physical Chemistry II is quite different from Physical Chemistry I. In this second semester of the Physical Chemistry course, you will study the principles and laws of quantum mechanics as well as the interaction between matter and electromagne.....more	cnx	unknown	0	15.73	import in moodle Learning Object preview recommendations
Jb0150r Review	This is a free course offered by the Saylor Consortium.Physical Chemistry II is quite different from Physical Chemistry I. In this second semester of the Physical Chemistry course, you will study the principles and laws of quantum mechanics as well as the interaction between matter and electromagne.....more	cnx	unknown	0	14.16	import in moodle Learning Object preview recommendations
Language Features, Primitive Types	This is a free course offered by the Saylor Consortium.Physical Chemistry II is quite different from Physical Chemistry I. In this second semester of the Physical Chemistry course, you will study the principles and laws of quantum mechanics as well as the interaction between matter and electromagne.....more	cnx	unknown	1	12.52	import in moodle Learning Object preview recommendations

Figure 3: Some of the retrieved LOs based on the query "Java data types", ordered by Tf-Idf (*score* column).

on the LMS. For each LO it is possible to analyze the course contexts in which it was previously used on the LMS, i.e., to identify: i) courses in which the LO appears; ii) the other LOs in the same section of the course where the LO is found; iii) the LOs in the earlier sections in a course with respect to where the LO appears; iv) the LOs in the later sections in a course, and v) which teacher is managing each of the relevant courses. In particular, the user can state at what "distance from the LO" she/he wants to consider the surrounding LOs (categories iii) and iv) above). Moreover, the list of courses where the LO is used is shown ordered according to the similarity of the querying teacher to the teacher managing the course. This permits the information in this phase to be more effective, as the information provided prioritizes courses which are deemed to be closer to those of the querying user in terms of the choice and selection of learning material. In this ordering by degree of similarity, the score is 0 if the teachers do not have shared LOs in their courses, but rises as the number of the LOs in common increases. This concept of similarity, defined in Deleted (2017), is computed according to the number of LOs two teachers have in common. Fig. 4 shows that by selecting the fourth LO presented in the ranked list (Java Data Types), we see from *MoodleRec* that there are two teachers with courses using that particular LO; these are ordered by decreasing similarity.

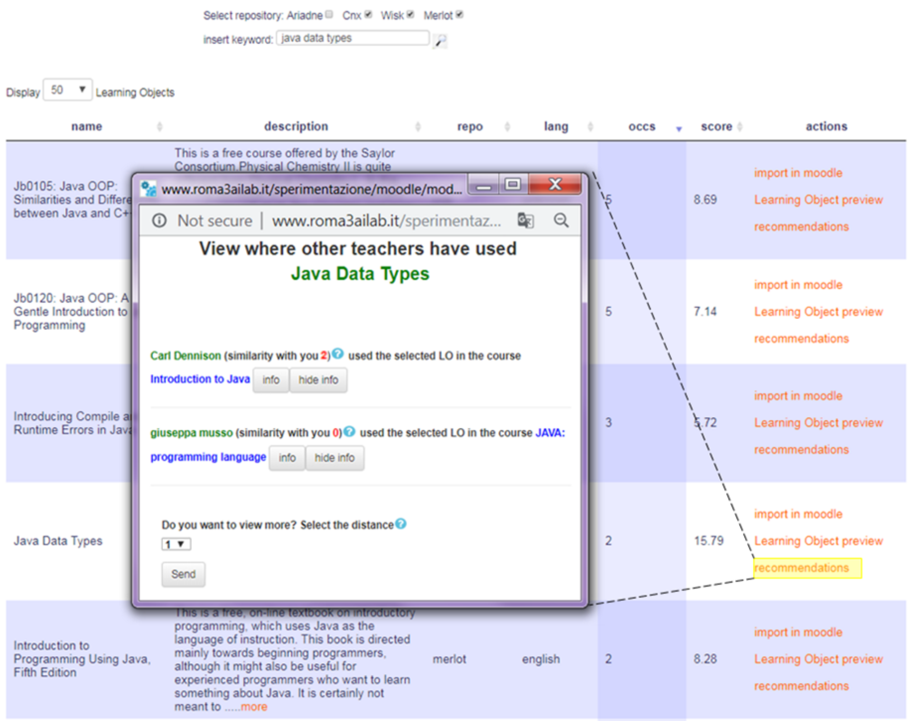


Figure 4: Users employing a particular LO are ordered by decreasing similarity. In the pop-up, two teachers have been ordered by their similarity with the user (similarity 2 and 1 respectively).

Fig. 4 shows how the teacher can look for further information on a LO in order to see the contexts in which it has been used in other courses. By selecting the "Info" button, a pop-up window appears (visible in Fig. 5). Besides providing information about the context of usage of the LO, this window allows the teacher to inspect the content of other materials that co-occur with the LO in a course ("Preview" button). She/he can import the LO directly into the Moodle course ("Import in Moodle" button) or start a new search for that topic in the LORs ("Search in Moodle" button).

4. Evaluation

This section discusses the experimental evaluation of the system by way of three different evaluations, one for each of the research questions proposed in Sect. 1:

- *RQ1.* This RQ aims to check the system capability in helping teachers to create a new course using its recommendations of new learning materials: *Does the recommending of LOs help teachers to create a new course?*

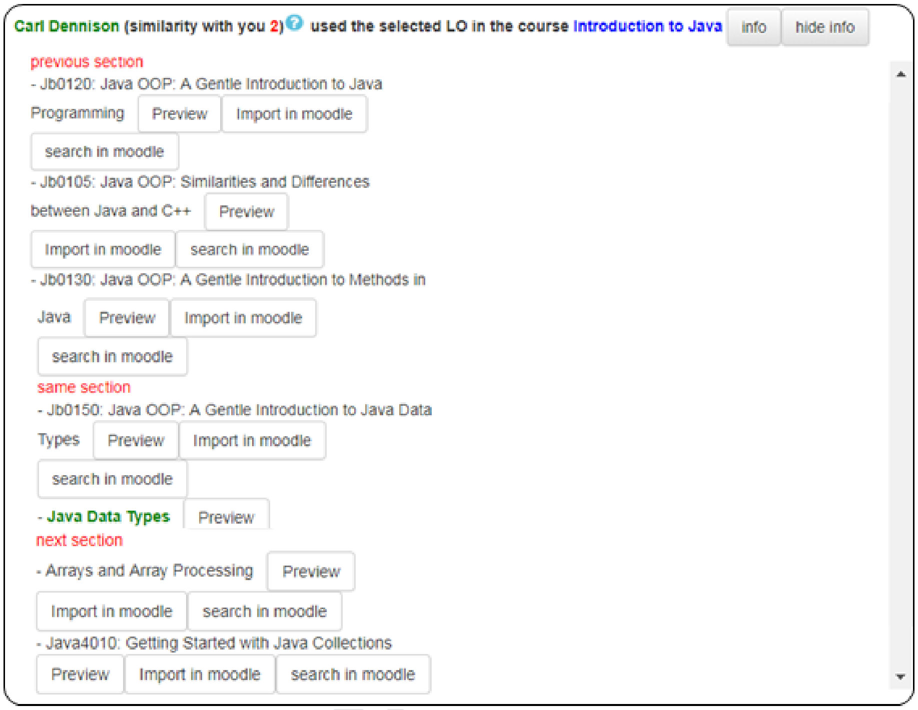


Figure 5: Pop-up showing the context of a course where the LO has been used by another teacher.

- *RQ2.* This RQ regards the level of user satisfaction when using the system: *Is the user satisfied by her/his experience in using the system?* We stress that the term *satisfaction* indicates the teacher's perception of the extent to which the system helped in creating new courses.

- *RQ3.* This question is aimed at checking the usability of the system overall: *Was the system considered usable by the sample that used it?*

Moreover, the evaluation ran on a new empty Moodle instance with the recommending extension configured as a *plug-in* and was available for approximately three months[1].

4.1. RQ1: Usefulness of the MoodleRec *Recommender Engine*

This regards the experimental evaluation of the recommending capability of the system. To this end, we propose the following standard evaluation plan for an *on-line* evaluation (Manouselis et al., 2011; Shani & Gunawardana, 2011):

[1]http://www.roma3ailab.it/sperimentazione/moodle/
To test the system directly, send a request to the authors.

- the sample,
- data gathering,
- the evaluation metrics,
- discussion.

4.1.1. The Sample

The evaluation was conducted on a random sample of 28 teachers enlisted through the SOFIA platform (SOFIA, 2018). SOFIA is a web platform made available by the *Ministry of Education, University and Research* of *(country, left blank for double blind review)*, deemed to support continuing education and professional development of teachers. It was a good solution to form the sample set of particpants in the experimentation of /moodlerec.

The sample was required to create one or more new courses on one of the following topics: Mathematics, Biology, Religion and Computer Programming. This was both to speed up the recommending process and to overcome any cold start issues in a reasonable amount of time.

4.1.2. Data Gathering

We gathered the following experimental data generated by the sample from the Moodle Log database:

- the number of new courses,
- the number of system recommendations followed / not followed,
- the number of LOs retrieved by the system,
- the distribution of retrieved LOs.

In Table 1 the set of data gathered from the Moodle log database is given, while Table 2 shows the distribution of the repositories from where the LOs used by the sample were retrieved.

# Teachers	# Courses	# LOs	Mean	St. Deviation
28	30	199	6.8	3.86

Table 1: The first column shows the total number of users; the second the total number of courses created by the sample and the third the total number of LOs actually used by the sample. The other two columns show the main statistical parameters of LO distribution in the courses.

	CNX	MERLOT	WISC	ARIADNE
LOs (%)	80	15	4	1

Table 2: Distribution of repositories from which the LOs were taken: most LOs used in courses were retrieved from the CNX repository.

# Used LOs	199
# Not recommended and used LOs	121
# Recommended and used LOs	78 (61 at d=1 and 17 at d=2)
# Recommended and not used LOs	280
# Recommender launches	317

Table 3: The Recommendation Data. The first row shows the total number of LOs used by the sample. The second row gives the number of LOs involved in the retrieval phase that were not recommended but used (without checking for recommendations). The third row indicates the number of LOs that were recommended and used: 61 of them were at distance $d = 1$, while 17 at distance $d = 2$. The fourth row shows the number of LOs recommended but not used. The bottom row gives the number of times the recommender module was questioned, but without suggestions given due to the cold start problem.

4.1.3. The Evaluation Metrics

The literature proposes many methods to evaluate recommender Systems. A general division of these quantities envisages the following two groups of evaluation measures (Isinkayea et al., 2015):

- *Statistical accuracy metrics* evaluate the accuracy of a filtering recommender system by comparing the predicted ratings directly with the actual user rating. The most common measures are: *Root Mean Square Error (RSME)*, *Mean Absolute Error* (MAE) and *Correlation*,

- *Decision Support accuracy metrics* help users to select very high quality items from a set of available items (Sarwar et al., 1998). The most frequently used metrics are the *Receiver Operating Characteristic* (ROC) curve, the *Precision-Recall* curve, Precision, Recall and F-measure.

As explained in previous sections, our system can be classified as a *Hybrid Recommender System* due to its operating features. For these reasons, our evaluation model is based on the following metrics: *Recall*, *Precision* and F_1 measure. These measures from the Information Retrieval area can be explained as follows: Precision determines the number of relevant items retrieved from all the items retrieved, that is, in this case, the proportion of recommended LOs that are actually good. Recall determines the number of relevant items retrieved from all the relevant items provided, that is, the proportion of all good LOs recommended. Finally, the F_1 measure can be used to gain a more balanced view of performance. The values of these variables are calculated from the figures in Tab. 3, thus obtaining the values shown in Tab. 4.

# TP	# FP	#FN
78	280	121

Table 4: The number of True Positive (TP), False Positive (FP) and False Negative (FN) cases. The number of True Negative cases (TN) is lacking.

Precision	Recall	F_1
0.22	0.39	0.28

Table 5: The evaluation measures of Precision, Recall and F_1.

Finally, Fig. 7 shows the use of the recommending engine together with the LO distribution, while Fig. 6 indicates the growing trend in the cumulative use of recommended LOs.

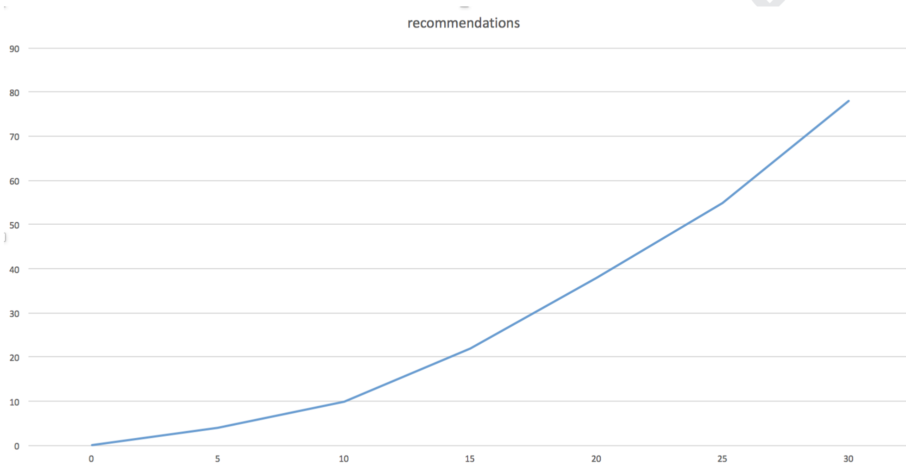


Figure 6: Results of *MoodleRec* use: the x-axis represents the number of courses in the system; the y-axis represents the number of recommendations followed by the teachers.

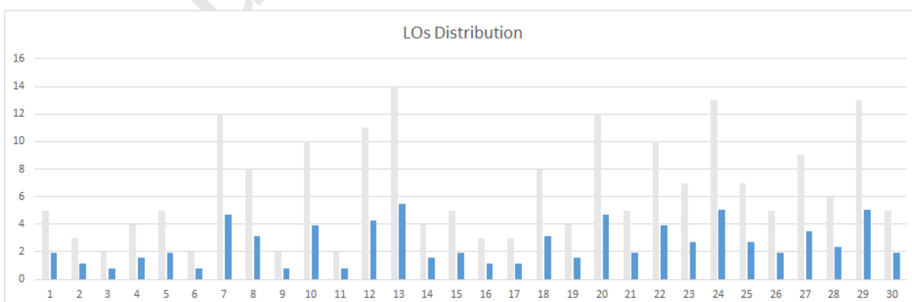


Figure 7: For each course, the lighter color denotes the number of LOs, while the darker color indicates the number of LOs recommended and used. There are 78 recommended and used LOs with mean $\overline{X} = 2.6$ and Standard Deviation $\overline{S}_X = 1.46$.

4.1.4. Discussion

The literature proposes different metrics and methods to evaluate Recommender Systems (Burke, 2002; Herlocker et al., 2004). One of the factors making any evaluation challenging is the *cold start* problem: at the beginning the system has few data to base recommendations upon, because there are few users and few courses using some LOs. Over time, the courses become populated and so the recommender can suggest LOs more meaningfully. This is also clear in our case if we consider Fig. 6, which highlights how the growth of the set of new courses influenced the acceptance of the recommendations, from the first to the final courses. Moreover, it is important to notice that the system initially proposes a classic approach by ranking the retrieved LOs using just the Tf-Idf metric based on a content filtering approach. From Tab. 5 we have a Recall value $R = 0.39$, a Precision value $P = 0.22$ and $F_1 = 0.28$. Although these values appear to be low, Fig. 6 provides very encouraging results as the amount of recommendations followed by teachers steadily increases as the system becomes populated with courses: it is low at the beginning, while it grows over time.

We can surmise that the use of *MoodleRec* could be more fruitful and beneficial once spread at a wide range, such as in several departments of the same HE institution, or even wider, with recommendations based on courses coming from different institutions, and different teachers, for different students. It would give the teacher a possibility to *find* (in the first place) and use good material that was in some way already experimented and considered trustworthy.

4.2. RQ2: User Satisfaction

We asked the participants to fill in a happy-sheet questionnaire made up of ten questions, submitted on the on-line Google-module platform. The questionnaire is shown in Fig. 8, while the corresponding results are given in Tab.6.

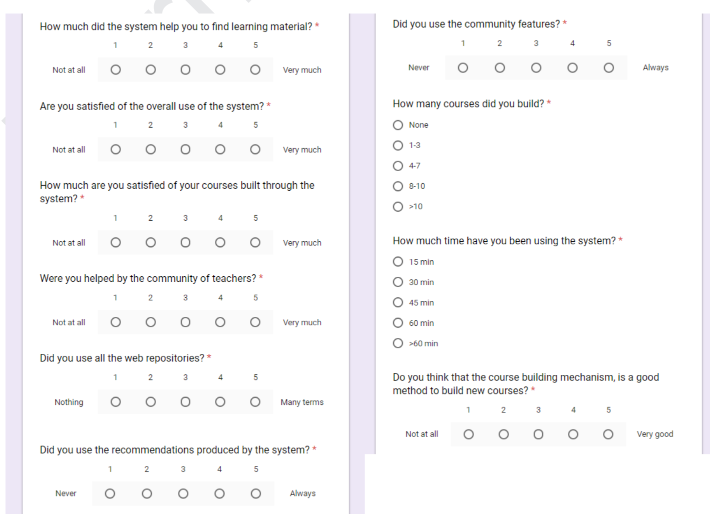


Figure 8: The Happy Sheet Questionnaire.

In order to answer the *RQ2*, we considered three sub-RQs, that we list in the following, pointing out the associated questions from the questionnaire.

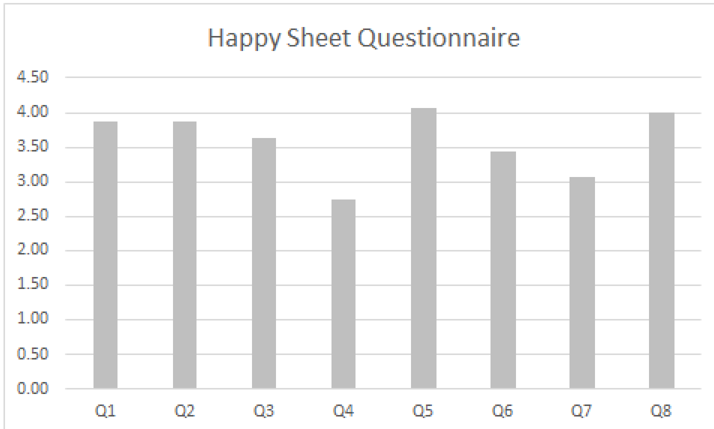


Figure 9: The distribution of answers to the Happy Sheet Questionnaire.

- $RQ2_1$: What is the sense of satisfaction depending on the perceived usefulness of the *MoodleRec* module. This is associated to the following questions
  - How much did the system help you to find learning material? (Question 1 in the questionnaire)
  - Were you helped by the community of teachers? (Q4)
  - Did you use all the web repositories? (Q5)
  - Did you use the recommendations produced by the system? (Q6)
- $RQ2_2$: Perceived use of the system and of the community features. This is associated to the following questions
  - Did you use the community features? (Q7)
  - How many courses did you build? (Q8)
  - How much time have you been using the system? (Q9)
- $RQ2_3$: General satisfaction, associated to the following questions
  - Are you satisfied of the overall use of the system? (Q2)
  - How satisfied are you with the courses you created using the system? (Q3)
  - Do you think that the course building mechanism is a good method to build new courses? (Q10)

For each question we obtained scores across almost the entire scale, but with an increasing distribution in the area of satisfaction. This result highlights the increase in user satisfaction consistent with the population of the system. In order to find a correlation between research questions and answers, we considered the percentage of answers denoting satisfaction for each question, i.e., with scores of 4 or 5 on the 5-point Likert scale. We then calculated the average scores for the answers regarding the $RQ2_1$ and $RQ2_3$ categories. The results are reported in Tab.6 and they highlight the users' satisfaction with the system. In particular, 61% of users were satisfied with the platform and thought that the suggestions proposed by the system were useful. We believe that this degree of satisfaction would grow with a more extensively populated version of the system, especially as during experimentation we also had to deal with the cold start problem. Finally, for the questions associated with $RQ2_2$ we found that 46% of users actively used the community features. Again taking into consideration the cold start problem, this is not necessarily to be interpreted as a discouraging result. In addition, around 80% of users spent more than one hour on the platform, and the number of courses they were engaged in ranged from one to three. We performed a consistency check of the happy sheet questionnaire by means of the Cronbach's alpha (Cronbach, 1951), obtaining a value of $\alpha = 0.911$, thus showing its high reliability.

RQ category	4 (good)	5 (very much)	4 and 5 combined
$RQ2_1$	38.25%	21.25%	59.5%
$RQ2_2$	33%	31%	63.3%
$RQ2_3$	33%	31%	63.3%
mean	34.75%	27.75%	63.03%

Table 6: Survey results. The first row shows the average results of the questionnaire items in the category dedicated to *RQ1* (usefulness of the *MoodleRec* approach): the average score for such items was 4 for 38.25% of the answers and 5 for 21.25%. We had the same values of answer distribution for $RQ2_2$ and $RQ2_3$. The bottom row shows the average values for the previous data. We interpret a score of 4 or 5 as denoting a good degree of usefulness or satisfaction; these results were provided by no fewer than 61.4% of users.

4.3. RQ3: System Usability

The system was evaluated from the perspective of usability, in order to garner useful information about the teachers' experiences. To this end, the teachers were asked to fill-in the *System Usability Scale* (SUS) post-session questionnaire comprising ten 5-point scale Likert questions. It was submitted to the sample through the on-line Google-module platform. The questionnaire is shown in Fig.10, while the results are shown in Fig. 11.

Originally created in 1986 (Brooke, 1996, 2013), this questionnaire enables a wide variety of products and services, including hardware, software, mobile devices, websites and applications, to be evaluated. It is a quick and easy way to obtain a valid measure of perceived usability from users, and is one of the most reliable and frequently used questionnaires recommended in the literature (e.g.: (Lewis, 2009)). Moreover, in (Orfanou et al., 2015) the authors show that the SUS questionnaire is also a valid tool for the assessment of LMS usability. This questionnaire was given to users after they had finished their tasks. SUS yields

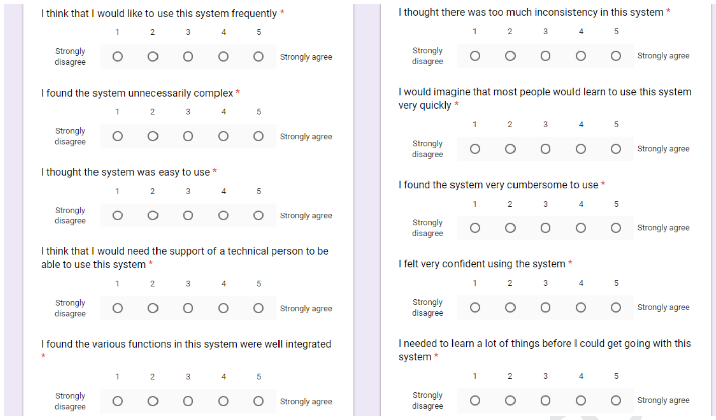


Figure 10: The Usability Survey SUS Questionnaire.

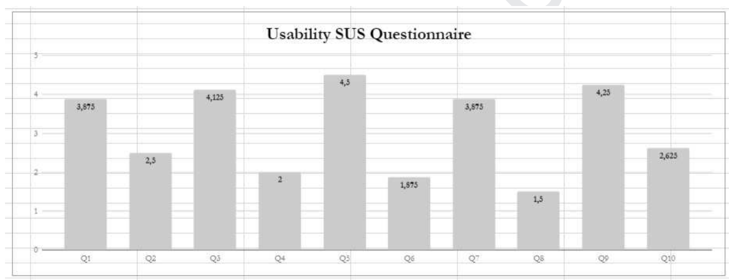


Figure 11: The distribution of answers to the SUS Usability Survey.

a single number representing a composite measure of the overall usability of the system being studied. To calculate the SUS score, first the scores from each item are added together. Each item can be scored from 0 to 4. For items 1,3,5,7, and 9, the score contribution is the scale position minus 1. For items 2,4,6,8, and 10, the contribution is 5 minus the scale position. The sum of the scores is then multiplied by 2.5 to obtain the overall value of SUS. By carrying out this procedure, we obtained a final score of $SUS = 70$. According to the evaluation suggested for SUS results[2] a score of < 51 corresponds to *Fail*, while a score of > 80.3 corresponds to an A evaluation. The *MoodleRec* result therefore seems to be rather satisfactory, particularly as there is potential for improvement.

Finally, in order to check the consistency of the SUS questionnaire, we calculated the Cronbach's alpha, obtaining $\alpha = 0.85$. This suggests that the items have high internal consistency: indeed, in most social science research situations a reliability coefficient of 0.70 or higher is considered "acceptable".

[2] https://usabilitygeek.com/how-to-use-the-system-usability-scale-sus-to-evaluate-the-usability-of-your-website/

5. Conclusions

From the debate that is ongoing in literature, on the use of technology for teaching and learning, it emerges that TEL fosters both teaching and learning, in particular in Higher Education.

In this work we addressed the teaching activity, presenting an extension of an LMS making it able to help the teacher build a course based on recommended LOs, whereas the recommendations come from the response of the LO to the requested features, and from the use that other teachers have done of the LO in different courses.

We have seen that the activity of building a course by including suitable LOs selected from LORs, has to confront with factors of inherent complexity. First, there is a multitude of LORs available, each with its own search tools, which are generally on-line and interactive. Second, the search response can provide the teacher with a huge number of LOs, so there needs to be a method for filtering the search results.

MoodleRec deals with the above mentioned complexities by allowing teachers to make a keyword-based query for LOs, searching through (possibly) many LORs at the same time. In the software module implementing the approach, the retrieved LOs are ranked according to: 1) their content match with the expanded query, and 2) their quality evaluation, as provided in their LOR of origin (where available). Furthermore, an analysis of the ranked list is underpinned by a social based feature. Working in an instance of the Moodle LMS, about a LO to analyze, the teacher can see:

1. how the LO has been used in other courses;
2. where it appeared along the flow of such courses, and, in particular,
3. what other LOs appear before, or after, the LO in such courses.

From this analysis of earlier uses of interesting LOs, the teacher can decide to select a given LO from those in the ranked list. She/he can also be encouraged to use other LOs, not listed in the query response, on the basis of their usage, alongside of the LO in question, in other courses.

We implemented our approach as a Moodle compliant module, installed it in a Moodle instance, and followed it up by an experiment. The results can be summarized by examining the answers to the research questions that were originally put forward.

The first research question regards how much of the system was actually used (i.e., whether the data from the social features and the available repositories were actually used), and whether the system was helpful in creating the course and the teacher actually accepted (used) the recommendations: *RQ1: Does the Recommending system help teachers create a new course.* Answers relating to this question show a good, 61.4% level of satisfaction regarding the effectiveness of using the *MoodleRec* approach. The second question was intended to measure the general satisfaction of users: *RQ2: Is the user satisfied by her/his experience in using the system?* The third question was asked to investigate system usability, and how much it was actually used: *RQ3: Was the system considered usable by the sample that used it?*.

In Sec. 4 we concluded that users were attracted to using the module for a (comparatively) good length of time, although only 46% of them actually used the social feature. Finally we should consider any limitations of the work described in this paper, and possible future developments. With regard to the second research question, we believe that our experimental approach can be modified, perhaps explaining the utility of the Community-Social feature more clearly to users. We had the distinct feeling that several teachers were intent on using first level LO search features, but were less interested in what could be discovered with regard to previous use of the LOs already in courses on the platform. Sadly, the cold start problem was probably more significant than we might have expected, and it is conceivable that the low recourse to social features was dependent on the relative poverty of the current Moodle instance. This is corroborated by the fact that the use of the "social recommendation feature" increased over time as the system content grew during the experimentation. As a matter of fact, the problem can only be solved by allowing for an extensive, non-experimental, use of the module prior to any further experimentation (and perhaps by explaining in greater detail some aspects of the module to the participants). A user model, based on the run time analysis of the educational contexts of the materials used, might work poorly in communities formed by just a few teachers who teach different subjects. In the future, a central server will be set up to collect the information of all active instances of *MoodleRec* and to calculate teacher models at run time. A further note regards the choice to allow *MoodleRec* to support keyword-based queries. We are aware that improvements to our approach are needed in order to allow the teacher to make queries that are more significant than those supported so far. In particular, a more fulfilling retrieval and recommendation system might be envisaged by adding the use of educational metadata such as the suggested use and duration of content, the pedagogical indications and, possibly, the intended target audience. One obstacle to the development of this finer analysis is, of course, the fact that the standards used for the specification of LOs can differ, as do the search features and metadata offered by the LORs. More semantic-oriented solutions are evidently in order, based on some of the items mentioned in the section regarding related work.

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Research Highlights

- Recommender system to create new courses using the Moodle platform
- Similarity metrics among teachers using courses in the same Moodle platform
- Learning Objects retrieval and import from web LO repositories
- Learning Objects ranking and selecting through system recommendations