

A flexible open source web platform to facilitate Learning Object evaluation

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Abstract— Systematic evaluation of Learning Objects is essential to make high quality Web-based education possible. For this reason, several educational repositories and e-Learning systems have developed their own evaluation models and tools. However, the differences of the context in which Learning Objects are produced and consumed suggest that no single evaluation model is sufficient for all scenarios. Besides, no much effort has been put in developing open tools to facilitate Learning Object evaluation and use the quality information for the benefit of end users. This paper presents LOEP, an open source web platform that aims to facilitate Learning Object evaluation in different scenarios and educational settings by supporting and integrating several evaluation models and quality metrics. The work exposed in this paper shows that LOEP is capable of providing Learning Object evaluation to e-Learning systems in an open, low cost, reliable and effective way. Possible scenarios where LOEP could be used to implement quality control policies and to enhance search engines are also described. Finally, we report the results of a survey conducted among reviewers that used LOEP, showing that they perceived LOEP as a powerful and easy to use tool for evaluating Learning Objects.

Keywords— *learning object; evaluation; model; metric; tool*

I. INTRODUCTION

The effective use of high quality Learning Objects (LOs) is one of success keys of technology enhanced education. LOs are reusable digital resources tagged with metadata that are self-contained and that can be used for education. They facilitate reuse [1], leading to minimization of production cost, time saving and the quality enhancement of digital learning experiences [2]. The multiple benefits of using LOs have been exposed by several empirical researches ([3], [4], [5], [6], [7]) that have examined their instructional effectiveness and learning outcomes across different educational environments.

Nowadays, thousands of LOs can be freely searched with standardized metadata through online educational repositories, also called Learning Object Repositories (LORs), facilitating teachers and students to obtain new materials. Nevertheless, due to the emergence of large repositories and the prevalence of low quality materials there are still some barriers that need to be overcome to extend the effective use these objects. First, teachers need some assurance of value and quality of the LOs before making them part of the curriculum. This need for quality assurance becomes even more important for students in self-direct educational settings, due to the risk of them being

misinformed by inaccurate content, or of wasting time with poor instructional designs [8]. Secondly, there is a need for including quality metrics in the sorting process of search results in order to save users' time when looking for new resources. Some studies [9], have pointed out that teachers can take over an hour to find an appropriate LO, and that several of them can note the search process to be time consuming and occasionally frustrating. All these barriers point out a clear need for LO quality evaluation and suggest that the systematic evaluation of LOs must become a common practice to make high quality Web-based education possible.

With the aim of addressing this need, many LO evaluation models have been proposed and some LORs have implemented tools for evaluating LOs based on those models. LO evaluation can bring several benefits. It enables LORs to implement effective quality control policies, which leads to higher quality resources since they can be evaluated before being published. Quality metrics enable search engines and recommender systems to provide better sorting and more enhanced recommendations respectively. Lastly, evaluations can provide useful feedback to LO developers. For these reasons, several LORs such as Merlot [10], OER Commons [11] or Connexions [12], have implemented their own LO quality evaluation system. An evidence of this trend can be found in [13], where 59 LORs were examined, indicating that 27 (46%) of them were following some quality control policy, whereas 23 (39%) had some resource evaluation/rating or review policy. In this study 23 different LO evaluation models were identified. This fact points out that no single evaluation model is sufficient for all scenarios due to the differences of the context in which LOs are produced and consumed [14]. So, there is a need for multiple LO evaluation models to coexist among LORs.

Despite the great amount of LO evaluation models that have been defined, no much effort has been put in developing open tools to facilitate the evaluation of LOs and use the evaluations and quality metrics for the benefit of end users. The current trend for LORs that want to implement a quality control policy is to develop their own evaluation model and evaluation tools. This option has three main shortcomings. First off, it is costly. Secondly, it fosters the use of non-tested and non-reliable LO evaluation models. Lastly, it plays an antagonistic role for achieving standard evaluation models and quality metrics for LOs. The work exposed in this paper aims to break this trend, or at least to provide an alternative way of providing LO evaluation in e-Learning systems.

This paper presents a flexible and customizable open source web platform that aims to facilitate LO evaluation. The name of the platform is LOEP, which stands for Learning Object Evaluation Platform. LOEP is the first open source platform for LO evaluation that can be freely used and customized by any educator, educational institution, LOR or e-Learning system and that is open to contributions from the community. LOEP is also the first evaluation system that supports and integrates multiple LO evaluation models, allowing its use in many different scenarios and educational settings. An instance of LOEP is currently available at <http://loep.global.dit.upm.es>. This instance was integrated with a LOR called Virtual Science Hub (ViSH - <http://vishub.org>) [15], and it was used by a team of 15 reviewers to evaluate many LOs of the repository. As validation and to further improve LOEP, we conducted a survey to collect feedback from reviewers on overall opinion, usability and proposed changes among others. The results of the survey are also exposed.

The rest of the paper is organized as follows. The next section reviews related work of LO evaluation. Section 3 provides an overview of some LO evaluation models that are available in LOEP. Section 4 explains LOEP in detail. Section 5 describes some scenarios of use. Section 6 shows the results of the survey. Finally, last section finishes with some concluding remarks together with an outlook on future work.

II. RELATED WORK

Significant discussion has been devoted to establishing a unifying definition of LOs across the last years [16], however, consensus has not been reached yet. LOs are defined in this work, based on previous definitions ([16], [17], [18], [19]), as “reusable digital resources tagged with metadata that are self-contained and that can be used for education”. Metadata include a description of the object and allow to improve the reusability, interoperability and discoverability of the LOs. The most used LO metadata standards are Dublin Core [20] and IEEE LOM [21]. Besides, LOM allows to define application profiles (e.g. CanCore [22]) to refine the original specification to make it more suitable for its application by a particular community. Several studies (e.g. [8], [23], [24], [25]) have claimed that metadata records may be the most suitable place to store quality information (e.g. users’ comments, ratings or peer reviews) of the LOs. However, this type of data is notably absent from the main metadata standards.

There are many models for evaluating the quality of LOs. These models can be classified depending on their concept of LO quality. Some of them only evaluate metadata quality (e.g. [26], [27]) or reusability (e.g. [28], [29]), while others evaluate the whole LO including a content quality evaluation from a pedagogical perspective. These models are termed LO pedagogical evaluation models. Examples of these models are among others LORI [30], LOEM [31], the MERLOT model [10], WBLT-S and WBLT-T [32], LOEI [33] and MECOA [34]. Lastly, there are hybrid models that combine different quality indicators. For instance, [35] obtains the overall quality of the LOs based on content evaluations, metadata quality and popularity. Other characteristic of the models is their intended audience. A model may require subject experts to conduct the evaluations, while others may require developers, teachers,

students or even not require human review. Automatic evaluation is possible for evaluating metadata quality as well as reusability when enough metadata are available, however, pedagogical evaluations always need human intervention.

Pedagogical evaluation models may be characterized in terms of the criteria they define to evaluate LO quality. Developing an effective evaluation model is quite challenging due to the compromise between the total number of criteria that can be evaluated and the reliability of the obtained evaluations. These models can be also described depending on the type of evaluations. Some models provide qualitative evaluations (e.g. reviews), while others provide quantitative evaluations (e.g. ratings or quality scores), quality certificates, notifications (e.g. approved/denied for publication) or a combination of several of them (e.g. ratings + comments). Among the ones that provide quantitative evaluations, some provide ratings for each criterion and others provide overall quality scores or both. A model may be also characterized based on the environment in which it is expected to be applied. Some models are designed to be used in a specific country or region (e.g. Europe) or in a certain educational setting (e.g. K-12 education).

LO evaluation tools enable to evaluate the quality of learning resources following a LO evaluation model, and also enable to use the generated evaluations to implement or enhance other services. These tools are usually web-based, and they are frequently used in LORs to implement quality control policies and obtain quality scores to enhance search engines. An example of these web-based LO evaluation tools can be found in the Merlot repository [10], where the resources are graded by users and appointed peer reviewers with comments and ratings on a 5-point scale according to three criteria: content quality, effectiveness as a learning tool and usability. The overall quality score, calculated as the equally weighted mean of the three criteria, is used to provide quality-based sorting of search results. The Connexions repository [12] offers a set of evaluation tools in order to provide a quality control for Open Educational Resources (OERs) via “lenses”. Connexions users have access to all resources in the repository (whatever their quality), and also they have the ability to preferentially locate and view resources that have been endorsed by third parties, also called “lenses”, such as editorial boards, professional societies or informal groups. Each third party can endorse resources based on different metrics and criteria (e.g. teaching experience, popularity, peer review). Other example is eLera [14], a website that provides communities of teachers, learners and developers with a set of web-based tools for collaborative evaluation of LOs based on LORI. Finally, another related example can be found in webLORI [36], an online version of the LORI evaluation model, which allows reviewers to evaluate LOs through a web application.

III. LEARNING OBJECT EVALUATION MODELS

To illustrate the variety and potential of LO pedagogical evaluation models, this section provides an overview of four of those models, which are available in LOEP.

A. LORI (*Learning Object Review Instrument*)

LORI is one of the better known models. A team of reviewers composed by subject experts and/or e-Learning

professionals can use LORI to create reviews consisting of ratings and comments on several aspects of LOs. The last version is LORI 1.5 [30], which considers 9 criteria: Content Quality (1), Learning Goal Alignment (2), Feedback and Adaptation (3), Motivation (4), Presentation Design (5), Interaction Usability (6), Accessibility (7), Reusability (8), and Standards Compliance (9). For each criterion, reviewers can enter comments and ratings on a 5-point scale. Reviewers can skip criteria that they are unable to assess or that they do not feel qualified enough to judge. Therefore, LORI provides qualitative evaluations (comments) and quantitative evaluations (ratings). Besides, it provides ratings for each criterion as well as an overall quality score obtained as the average rating of all criteria. LORI is intended to cover a wide range of educational settings, but it is worth pointing out that it only evaluates LOs from the reviewers' perspective. LORI has been tested in a few studies ([8], [24]), which have shown that it can be used to reliably assess some aspects of LOs.

B. LOEM (Learning Object Evaluation Metric)

LOEM allows reviewers to evaluate LOs according to four distinct constructs: interactivity, design, engagement and usability [31]. The interactivity construct considers 3 criteria: Meaningful Interactions (1), Overall Control (2) and Learning Value added by Multimedia (3), design considers Consistency (4), Layout (5), Labeling (6) and Readability (7), engagement covers Quality of Feedback (8), Attractive (9), Graphics (10), Learning Mode (11) and Motivation (12), and lastly the usability construct tackles Natural to Use (13), Orientation (14), Navigation Cues (15), Instructions (16) and Appropriate Language Level (17). Reviewers rate each of these 17 criteria on a 3-point scale providing quantitative evaluations. The score for each constructor is calculated by adding the ratings of its criteria. However, the model does not specify the weights for each constructor or criterion in order to calculate an overall quality score. In these cases, it is common to define the overall quality metric as the average rating of all criteria. LOEM has been tested in middle and secondary schools [31], showing that is a reliable, valid and effective approach for LO evaluation in those environments.

C. WBLT-S (WBLT Evaluation Scale for Students)

The goal of WBLT-S is to assess the effectiveness as educational tools of the LOs in the classroom from a student's perspective. WBLT stands for Web-Based Learning Tool and is a term used as a synonym of LO. This method is a refinement of a previous one called LOES-S [37]. WBLT-S is intended to be applied by students that have used the LOs in order to evaluate them according to three constructs: learning, design and engagement. The learning construct considers 5 criteria, design 4 and engagement another 4. See [32] for details. Students rate each of these 13 criteria on a 7-point scale providing quantitative evaluations. Besides, they can add comments about what they like and do not like about the LOs providing this way qualitative evaluations. The score for each constructor is calculated by adding the ratings of its criteria. However, the model does not specify the weights for each constructor or criterion in order to define an overall quality metric. WBLT-S has been tested in middle and secondary

schools [32], suggesting that it is a reliable and valid model that can be used to assess the quality of LOs.

D. WBLT-T (WBLT Evaluation Scale for Teachers)

WBLT-T aims to assess the effectiveness as educational tools of the LOs in the classroom from a teacher's perspective. It is a refinement of a prior method called LOES-T [9], [38]. WBLT-T is intended to be used by teachers that have employed the LOs in their lectures in order to evaluate them according to three constructs: learning, design and engagement. The learning construct considers 4 criteria, design 3 and engagement 4. See [32] for details. Teachers rate each of these 11 criteria on a 7-point scale providing quantitative evaluations. Besides, they can add comments about their teaching experience thus providing qualitative evaluations. The score for each constructor is calculated by adding the ratings of its criteria. However, the model does not specify the weights for each constructor or criterion in order to define an overall quality metric. WBLT-T has been tested in middle and secondary schools [32], suggesting that it is a reliable and valid model to assess the quality of LOs.

IV. LEARNING OBJECT EVALUATION PLATFORM

LOEP is a web platform that aims to facilitate the evaluation of LOs according to multiple models, and the generation and sharing of quality scores. It is open source and its code is available at <http://github.com/agordillo/LOEP>. Any individual, educational institution, repository or e-Learning system can freely use LOEP. It is open to contributions and feedback from the community in order to achieve a unified and robust solution for the evaluation of LOs and the sharing of quality scores. LOEP intends to be flexible, extensible and customizable. Flexible in the sense that can be used in different scenarios and educational settings, extensible in the sense that can be easily extended with new evaluations models and metrics, and customizable in the sense that can be easily modified to add new services or functionalities. The schema of Fig.1 represents the main entities that make up the LOEP platform. Next, each of these entities is explained.

User. LOEP provides user management handling three roles: admins, reviewers and guests. Admins can appoint new reviewers, add LOs to the platform and create assignments to request certain reviewers to evaluate specific LOs. In addition, they can register applications allowing external repositories and e-Learning systems to securely communicate with LOEP. If a LOR wants to use LOEP, an admin must register it as an application. Subsection C details the features that LOEP can offer to admins. Reviewers have an assignment list that indicates which LOs they should evaluate. Moreover, reviewers may freely review public LOs although they have not been assigned. Subsection B describes more deeply the features of LOEP for reviewers. Finally, guests are users with very limited permissions. They are allowed to access certain areas of the platform such as the documentation page, but they cannot perform reviews or create or modify any other entity.

Assignment. An assignment requests a reviewer to evaluate one single LO according to a LO evaluation model. When administrators create "complex assignments" that involves

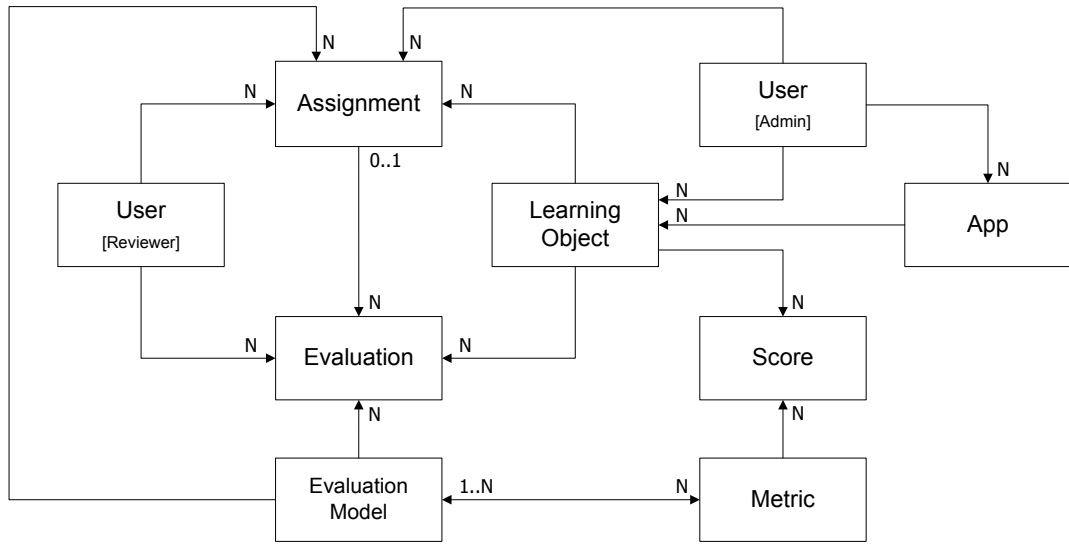


Fig. 1. Learning Object Evaluation Platform: Entities schema

several reviewers, LOs and evaluation models, they are generated by creating multiple simple assignments. An assignment may have one single or many related evaluations depending on the model. Evaluation models for external reviewers such as LORI only allow one evaluation per user and LO, however, other models such as WBLT-S allow several evaluations per assignment. This is useful for instance, to record in a single assignment all the evaluations of a LO carried out by students of a same class.

Learning Object. Admins and external applications such as LORs are allowed to register or add new LOs in the platform. LOs can be added specifying three different scopes: Public, Protected and Private. Public LOs can be shown and evaluated by any reviewer. Reviewers can show protected LOs but they only can evaluate those for which they have assignments. Lastly, private LOs can only be shown and evaluated by reviewers that have been specifically assigned. LOEP stores all the LO evaluations performed with the different evaluation models. Grounded on these evaluations, several scores can be calculated for each LO according to different quality metrics.

Evaluation. Reviewers evaluate LOs using web forms. Each time a reviewer fills and submits a web form, a new evaluation is created. An evaluation is always carried out according to a LO evaluation model and only rate one LO. Reviewers can create evaluations as a result of an assignment, or because they reviewed some public LO on their own initiative. Given that, an evaluation may or may not have an associated assignment.

Evaluation Model. The models applied to evaluate LOs are also entities of LOEP. They enable to judge LOs according to the criteria that they specified, and to define quality metrics that make use of their evaluations.

Metric. Metrics are quantitative measures of LO quality. Several metrics can be defined based on the same LO evaluation model and several models can be used to define a quality metric. Furthermore, metrics can be built upon other

metrics. A metric is characterized by the evaluation models and criteria it takes into account, the mathematical process it uses to calculate the measure of LO quality, and the scale in which the final numeric value is provided.

Score. A score is a numerical rating of a LO calculated according to a quality metric. A different score can be calculated for each type of metric. Given a certain LO, is possible to calculate a specific score if the LO has been evaluated with all the evaluation models required by the metric of that score. For instance, if a quality metric is defined as the average rating of all LORI criteria, it would be possible to calculate scores based on it for all LOs evaluated with LORI.

App. Administrators can register external applications such as LORs in the LOEP platform. A registered application has the same permissions as the admin who created it. Thus, external authorized websites can realize actions similar to those performed by human admins. For instance, they can create assignments, register new LOs and get information from the database such as evaluations and quality scores.

A. Evaluation Models and Metrics

The current version of LOEP supports all the evaluation models described in Section 3: LORI 1.5, LOEM, WBLT-S and WBLT-T. Some enhancements have been made when implementing these models. For instance, an optional field for proposing an overall score for the LO has been added to the web forms. Furthermore, since LOEM lacks of qualitative evaluations, a field for general comments has been included in its web form. Although this first version of the platform only supports these four models, LOEP has been designed to be easy to extend with new LO evaluation models. The idea is that existing LORs can integrate their own models on the platform with little effort. Future plans for the platform includes implementing new evaluation models, which will allow not only new ways of evaluating LOs from a pedagogical perspective, but also to automatically evaluate metadata quality and reusability.

Several quality metrics are defined in the base version of LOEP. For each of the aforementioned evaluation models, a quality metric that calculates the overall score as an average rating of all criteria and provides the result in a 0-10 scale has been implemented. Besides, some more complex metrics are defined for LORI. An example of these metrics is the LORI Weighted Arithmetic Mean quality metric. This metric calculates the score of a LO as the weighted arithmetic mean of all LORI criteria scores, giving different importance to each criterion according to a weights vector $\{W_1, \dots, W_9\}$, where W_i corresponds to the weight of the LORI i th criterion. The equation that calculates the LO score takes an input score vector $\{i_1, \dots, i_9\}$, being i_i the score of the LORI criterion i in a scale from 1 to 5, and yields a single real value in a scale from 0 to 10 according to the following expression:

$$s(\{i_1, \dots, i_9\}) = \frac{5}{2} \times \sum_{i=1}^9 W_i \times (i_i - 1), \quad s(\{i\}) \in [0, 10] \quad (1)$$

where $\sum_{i=1}^9 W_i = 1$ and $W_i \geq 0 \forall i \in \{1, \dots, 9\}$

It is possible to create new custom metrics based on this general expression by specifying the weights vector. Moreover, LOEP has been designed to facilitate the definition of new metrics based on different criteria and quality models. For instance, we can easily define a new metric that calculates the overall score of a LO as the average of the LORI Content Quality and LORI Presentation Design or as the average of the LORI, LOEM, WBLT-S and WBLT-T scores.

B. LOEP for Reviewers

Fig. 2 shows a screenshot of LOEP when a reviewer is evaluating a LO with LORI. Reviewers have a list of

assignments with all LOs for which they have been selected as evaluators. If a reviewer is not able or does not feel qualified enough to evaluate a LO, he/she can reject the assignment. Admins are notified of this rejection, so they have the choice of reassign the LO to other reviewer. On the other hand, reviewers may browse the public LOs and evaluate any of them with any model although they have not been specifically assigned to do it. Reviewers can show all their evaluations. However, they are not allowed to edit evaluations that have been carried out in the context of an assignment which deadline has been expired. Thus, they only can edit evaluations of open assignments and the ones they have performed on their own initiative. There also training materials for reviewers and useful documents available in the platform. For instance, regarding LORI, users can download the official LORI user manual or a printable version of the LORI evaluation form.

C. LOEP for Admins

Admins can appoint new reviewers by inviting people to join the platform or by granting the role to existing users. Besides, as explained previously, they can register external applications enabling their communication with LOEP.

LOEP admins can order assignments to review LOs in two ways: manually or automatically using matching algorithms. In both cases, they have to select which LOs are going to be evaluated, which reviewers will carry out the evaluations and the evaluation models that will be used. Optionally, they can write a description and specify a deadline for the assignment. With the manual procedure, an admin has to indicate manually which reviewers will evaluate each LO. With the automated alternative, admins have to specify the desired number of evaluations per LO, and the strategy for matching LOs with reviewers in order to automatically share out the assignments.

The screenshot displays the LOEP interface for a reviewer named John Doe. The main menu on the left includes Home, Assignments, Evaluations, Documentation, Surveys, and Sign out. The central area shows the evaluation form for 'Introducción al Análisis de Circuitos' with LORI v1.5. The form includes three sections: 1. Content Quality (score 5), 2. Learning Goal Alignment (score 4), and 3. Feedback and Adaptation. Each section has a description and a rating scale from Low to High. The 'Content Quality' section is currently selected and shows a score of 5. The 'Learning Goal Alignment' section shows a score of 4. The 'Feedback and Adaptation' section shows a score of 0. The interface also includes a Learning Object URL and a link to the LORI v1.5 documentation.

Fig. 2. Evaluating a Learning Object with LORI in the Learning Object Evaluation Platform

The following three matching strategies are offered in the current version:

Prioritize workload balancing with random matching. This strategy ensures that all reviewers will have to evaluate almost the same quantity of LOs. When using this basic strategy, the matching is done randomly.

Prioritize workload balancing with best-effort matching. Same as the prior strategy, but now the matching is done using a best-effort approach. The LOs assigned to a reviewer are selected according to the suitability of the match. This suitability is automatically calculated based on the user profile of the reviewer and the LO metadata. This process takes into account several factors like the language and topic of the LO, the mother tongue and other languages known by the reviewer and his/her areas of expertise. With this best-effort strategy, several rounds are carried out to share out all the LOs among the reviewers. In each round, each reviewer is matched with the most suitable LO among the available ones.

Prioritize reviewer suitability. With this strategy, instead of looking for the most suitable LOs for each reviewer, the most suitable reviewers are assigned to each LO.

Admins can show detailed information of the LOs including their metadata, assignments and evaluations, and data related to LOEP like owner and scope. Besides, if a LO has been evaluated, the available scores are shown, and the corresponding charts that summarizes the results of the evaluations are drawn (Fig. 3). All this information can be downloaded in XLSX format, so it can be processed using spreadsheet software such as Microsoft Excel or LibreOffice Calc. Moreover, LOEP provides a ranked list in which admins can sort the LOs according to the different quality metrics.

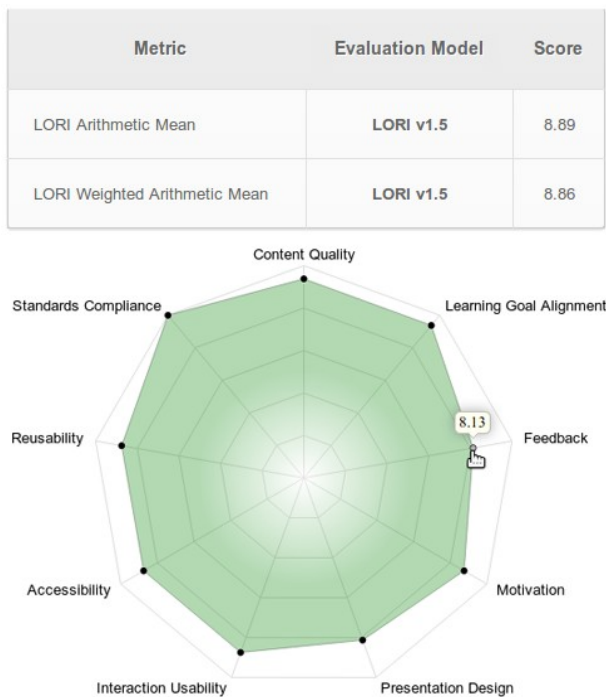


Fig. 3. Scores of a Learning Object evaluated with LORI

Another powerful tool of LOEP is the LO search engine. This tool allows admins to search LOs by metadata (e.g. name, language, keywords) and other parameters and advance options. It is possible to search for LOs that include or not include specific elements (e.g. text, images, videos, quizzes, flash objects, applets, etc.). Besides, it is possible to search for LOs that have been or have not been evaluated with a certain model. For instance, we can search for LOs in English that contain quizzes but not videos, and that have been evaluated using LORI. The user interface is still a bit limited in this first version of the platform, but it gives admins the option to write directly SQL queries in the web form to perform complex searches. All LOs included in the search results can be downloaded in XLSX format. Finally, LOEP includes features to compare LOs and get aggregated statistics of groups of LOs.

V. SCENARIOS OF USE

A. Implementing a Quality Control Policy

The quality control policies of the repositories may be quite different. For instance, OER repositories usually allow to publish resources whatever their quality, but they try to give more visibility to the ones with higher quality. On the other hand, many repositories require the resources to be evaluated before being published to guarantee a minimum quality.

LOEP can be used to implement a great variety of quality control policies, and thus LORs can use it to enforce their own one. Fig. 4 shows a scenario in which a LOR has used LOEP to implement a typical quality control policy, with the aim of preventing low quality resources submitted by end users to be published. Once the user submits the LO, the LOR register it in the LOEP platform. Then, the assignments to review the LO can be generated automatically by the LOR or manually by some LOEP administrator. In this example we are going to suppose that the LOR automatically orders to review the LO with LORI 1.5, indicating that it should be evaluated by at least two reviewers, and that the reviewers should be selected using the “prioritize reviewer suitability” strategy. The LORI Weighted Arithmetic Mean quality metric is used. Besides, in this case LOEP has been extended with a new metric and a new model to automatically evaluate metadata quality, and the LOR also orders to evaluate the LO with this model. Each time a reviewer completes an evaluation of the LO, LOEP notifies the LOR with the updated information of the LO, including its scores, which can be stored in the database. In this example, the LOR waits until the LO has two LORI evaluations, and it approves the LO if both the LORI and metadata quality scores are higher than 5. If the LO submission is denied, the LOR may send the user (or LO author) the feedback provided by the reviewers in their evaluations.

B. Enhancing Search Engines and Recommender Systems

Following with the prior scenario (Fig. 4), the LOR can store the LO scores and use them to provide quality-based sorting of the search results. Also, the quality metrics provided by LOEP can be used to define better ranking metrics and improve the search of LOs. Similarly, if recommender systems have access to quality information, they will be able to provide enhanced recommendations.

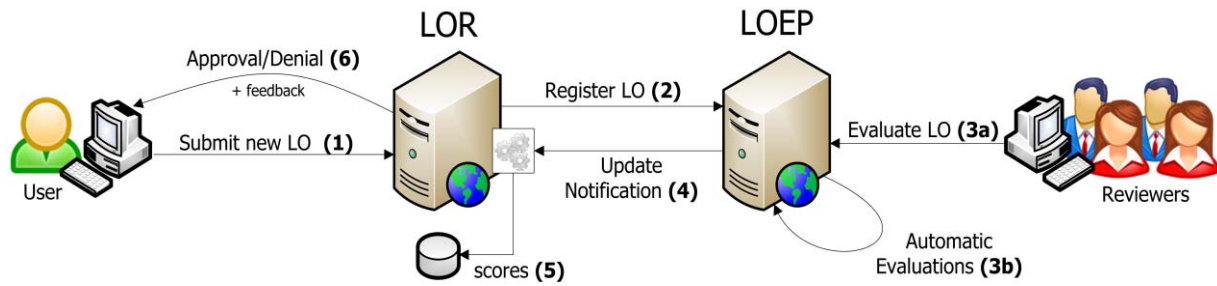


Fig. 4. Implementation of a Quality Control Policy using LOEP

C. Research on LO Quality indicators

LOEP may also be a powerful research tool. Thanks to its search engine and its features to compare and get aggregated statistics, LOEP can be used to identify factors that influence on the LO quality as well as to investigate the relations among the different quality models and metrics.

VI. EVALUATION

An instance of LOEP (<http://loep.global.dit.upm.es>) has been used for over 4 months in order to evaluate the LOs of the ViSH repository (<http://vishub.org>) [15]. To this day, the ViSH reviewers team has evaluated more than 200 LOs using LORI, generating more than 700 evaluations (each LO is evaluated by at least 3 reviewers). The team is formed by 15 reviewers (4 e-Learning professionals, 9 educators and 2 designers), two of whom also operate as LOEP administrators. A survey among the team members was conducted to collect feedback on overall opinion, usability and proposed changes among others. Table I summarizes the results of the survey.

TABLE I. LOEP SURVEY RESULTS

Please indicate your level of agreement on each of the following statements about LOEP [1 (strongly disagree) - 5 (strongly agree)]	Reviewers (n=15)		Admins (n=2)	
	M	SD	M	SD
LOEP is easy to use	4.5	0.6	5.0	0.0
LOEP saves me time	4.1	0.8	5.0	0.0
Makes my job as a reviewer easier	4.7	0.5	-	-
I have improved my ability to judge the quality of LOs after using LOEP	4.0	0.9	-	-
I think my assignments were suitably ordered according to my profile	3.7	1.1	-	-
The documentation is easy to find	4.3	0.8	4.5	0.7
The documentation is truthful, accurate, well presented, and has the appropriate level of detail	3.9	0.8	4.5	0.7
LOEP can be very useful for LORs, Learning Management Systems and Educational Content Providers	4.5	0.5	5.0	0.0
LOEP can be very useful for educational institutions	4.1	1.0	4.0	1.4
	Yes	No	Yes	No
If you had to evaluate a set of LOs, would you like to use LOEP again?	100%	0%	100%	0%
Would you recommend LOEP to others?	100%	0%	100%	0%

In this study, the sample consisted of 15 reviewers, 9 males (60%) and 6 females (40%), 23 to 43 years of age ($M=30.8$, $SD=5.6$). Two of these reviewers also operate as admins, both males, one was 31 years old and the other 26. The reviewers' overall opinion of LOEP was very positive: 26.7% had an excellent opinion, 73.3% good, and nobody had a neutral/bad/awful opinion. The overall opinion of LOEP from the admins' perspective was also very positive since they had an excellent opinion about the tools LOEP provides for admins. In general, reviewers and admins found LOEP easy to use, they perceived LOEP as a very useful tool for LO evaluation, and they were extremely favorable to use it again in the future.

VII. CONCLUSIONS AND FUTURE WORK

This paper presents LOEP, an open source web platform that aims to facilitate LO evaluation in different scenarios and educational settings by supporting and integrating several evaluation models and quality metrics. The work exposed in this paper shows that LOEP is capable of providing LO evaluation to e-Learning systems in an open, low cost, reliable and effective way. Thus, it can be used to implement quality control policies with little effort as well as to enhance search engines. Furthermore, the feedback received by a team of reviewers that used LOEP to evaluate the quality of the LOs offered by a LOR was very positive, showing that LOEP is easy to use both as a reviewer as administrator, and that it is perceived as a very useful tool for LO evaluation.

The systematic evaluation of LOs must become a common practice to make high quality Web-based education a reality. This work also exposes the need for tools that facilitate this systematic evaluation and the importance of supporting multiple models and quality metrics. In order to share and reuse the quality information of the evaluated LOs, further work is needed to develop tools for the automatic mapping between quality metrics based on distinct LO evaluation models, and to define a standardized way of sharing this information.

Future plans for the platform includes implementing new metrics and evaluation models to automatically rate metadata quality and reusability. Besides, we are going to integrate into LOEP an open source web videoconference service to facilitate collaborative evaluation. Finally, we also plan to define and propose an application profile for the IEEE LOM standard, with the aim of storing the quality information of the LOs in a standardized way, including their scores and the metrics and evaluation models that were used to obtain them. This way, the scores and results of the evaluations stored in LOEP will be able to be shared and reused over the Internet.

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