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Learning Object Recommendation for Teachers Creating Lesson Plans

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Abstract.E-learning is one of the most popular and beneficial uses of the Internet today. However, it presents a problem known as the "information overload". Current systems of e-learning stored too many contents: on various topics, for different ages, etc..; therefore users often are not sure how to find what they are needing between all the contents available. And this problem is even greater when considering that most current e-learning systems have simple search engines as tools to find resources. In this paper a new algorithm that incorporates recommendations of learning objects from a repository on an e-learning system is presented. At the end, a case study is performed to evaluate the proposal. Techniques of artificial intelligence are used to filter and customize information and recommended items.

Keywords: Learning Object, e-learning, recommendation, lessons plans.

1 Introduction

E-Learning has been defined by Nichols [1]as "the use of various technological tools that are either Web-based, Web-distributed or Web-capable for the purposes of education." Although researchers debate on the definition of e-learning and other related terms [2], we have considered Nichols' definition as a contextual reference for the development of a recommender system to support teachers in the development of lesson plans.
Recommender systems (RS) are information systems used to suggest ideas, products, learning objects and other items to their visitors. A RS helps users to choose without having enough experience with options to select, helping them to decide for what would be the best option for them [3].

These RS can be integrated with e-learning environments and are an alternative solution to the problem of overload of educational contents existing now in these educational platforms. That is, at present, users of e-learning platforms struggle to find relevant information due to the large amount of content and the existence of inflexible searches. However, with the help of RS, users may find learning object that were needed in a simple way, since the system builds profiles with the tastes and preferences of users, and employs such information to recommend items that are close to their needs.

In this work, the incorporation of a recommender system of learning objects to an e-learning platform is proposed. This platform is used by teachers to create lesson plans. The engine of the system is the recommender algorithm, takes into account aspects related to the user's profile and also information gathered from the Facebook social network to improve the accuracy of the recommendations. The system aims to help teachers improve their lesson plans by suggesting learning objects and related material that may later benefit students.

The article is structured as follows: Section 2 presents related works. Section 3 presents the recommender system of learning objects and related material, along with an explanation of the model on which it is based. Finally, in section 4 the case study is presented and in section 5 the conclusions and future direction of the work.

2 Related Works

Manouselis[4] have reviewed the use of recommender systems in technology enhanced learning contexts. The review describes recommendation algorithms and learning applications, as in Walker [5] in which the authors try to explore how user evaluations of learning resources may be propagated in recommendations about the qualities of the resources. Another system described briefly in the review is Questions Sharing and Interactive Assignments, designed specifically for the sharing of learning resources in online communities [6]. Other initiatives on the use of recommender systems in e-Learning environments may also be highlighted, such as:

- Cazella [7] proposed the use of a recommender system to suggest scientific articles to students in mobile devices. The recommender model proposed is based in a collaborative filtering approach which takes user context into account. Results showed that the accuracy of the predictions generated by the model was 79.75%.
- Santos [8] incorporated recommendations for e-learning systems in which students receive suggestions tailored to their learning style and context of use.
- Carrillo et al. [9] proposed a system to help patients diagnosed with Diabetes Mellitus to learn a bit more about the disease. The tool uses data and analytical measurements of patient history, and with that information the system recommends a series of learning tips and training contents.

While these approaches of recommender systems for e-Learning differ in the scope or goals of the proposal, all these projects focus on the problem of filtering information to students in a world overloaded with data and information. In our project, a similar goal has been considered, but this time trying to assist teachers in the selection of educational material for their students. The next section details the proposed recommendation approach.

3 Recommender System in e-learning

The recommender system for learning objects is based on the use of several pieces of information collected in different ways:

- **Keywords** are informed by the user when he/she creates a lesson plan;
- **relevant terms** are identified by a text mining tool while the user is creating/writing the lesson plan;
- **Learning objects *liked*,** collected in a Facebook learning community.

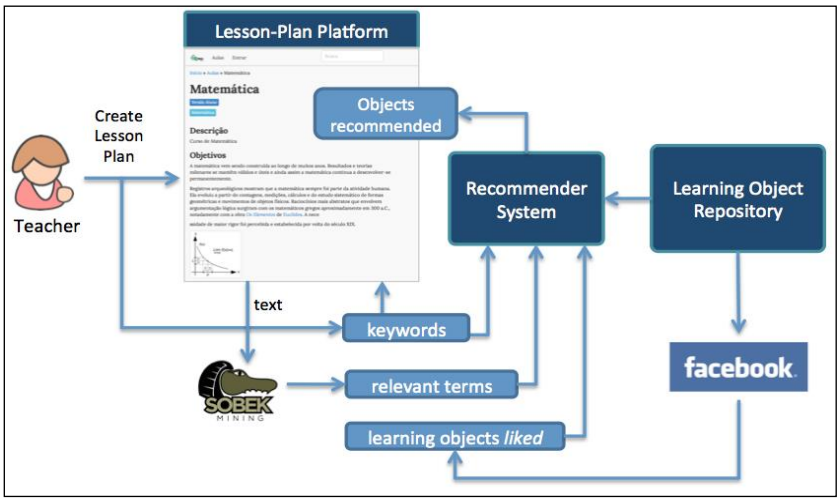

Fig. 1. Process model for recommending learning objects.

The process starts with the teacher creating a lesson plan and informing keywords explicitly in the plan registration. While the teacher is writing the lesson plan, the Sobek mining tool extracts relevant terms from it, and provides this information to the Recommender System, whose goal is to recommend contents to the teacher from a Learning Object Repository. These objects are rated (*liked*) in Facebook by the users of the Lesson Plan Platform. This information is also provided to the Recommender System, which then performs the necessary computation to recommend a set of objects that may interest the teacher in the development of his/her lesson plan. Each of the systems involved in this architecture is detailed in the subsections below.

3.1 The Lesson Plan Platform

The Lesson Plan Platform has been developed with the goal of allowing teachers to structure and share their lesson plans in any domain. It aims to make lesson planning a structured process in which teachers describe goals, strategies and instruments to be used in their classes. During this process, the tool automatically identifies the main topics of the course and then tries to recommend related contents. The tool has been developed in *PHP* and *Java*,also using the*YiiFramework*(http://www.yiiframework.com/) and *Postgre*.

The tool allows teachers to incorporate different components in their lesson plans: text, images, videos, and links. In addition, a logical organization is suggested. When the lesson plan is finished, teachers may save it in different formats to be consulted by other teachers or by students. Another interesting aspect of this application is the possibility of recommending different lesson plans for teachers at the time they create a new one. In this paper, we detail the recommender algorithm use to recommend related contents from a learning object repository.

The next section describes the Sobek tool, which is used to analyze the teachers' lesson plans in order to identify relevant terms that may be used in the search for related contents.

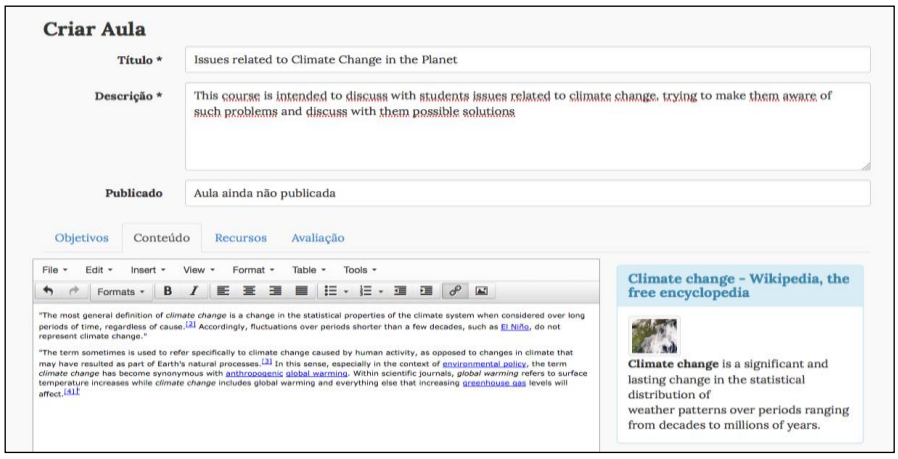

Fig. 2. Contents recommended to the user (on the right) related to the lesson plan being edited (Climate Change).

3.2 Sobek

Sobek Text Mining [10] is an open source mining tool that allows the extraction of relevant terms and relationships between words in a text. The text mining algorithm has been based on the n-simple distance graph model, in which nodes represent the main terms found in the text, and the edges used to link nodes represent adjacency information [11]. The system has been used in different educational applications, as in:

- Supporting teacher's work in evaluating student's text productions;
- Assisting students in reading comprehension activities;
- Summary writing;

Figure 3 gives an example of a graph built by Sobekfor a text about the Atomic Bomb. Determining the importance of each term is based on the analysis of the frequency of occurrence of that term in the text. The relationships between terms,the edges of the graph, are determined based on a mathematical computation that measures the distance between two terms in the text based on the number of words between them.

In this project, Sobek has been embedded in the Lesson Plans Platform in order to identify terms used in teacher's texts that can be used to search for related contents. These terms are used in web searches, as well as in more specific searches in a Learning Objects Repository, which is described in the section below.

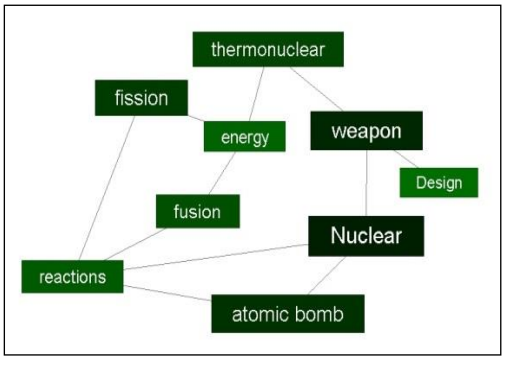

Fig. 3. Graph that represents relevant terms extracted from a text about the atomic bomb.

3.3 Learning Objects Repository

Learning objects may be defined as a "small, reusable educational chunks of digital information that educators and trainers can archive and use in their course building and also share with others" [12]. The archiving of these objects in learning repositories promotes collaboration and supports the reuse of material that has already been produced in the past.Learning objects must have an information structure to facilitate their identification, storage and retrieval: Metadata [13].

In this project we have opted for using the FEB Learning Object Repository, which provides a single point of access for several individual repositories, in the form of a web portal with search capability. FEB employs a federated architecture, in which each node may be composed of other federations or standalone repositories [14].

FEB has a simple interface that allows users to use keywords to search for learning objects in all of the federated repositories, as depicted in figure 4.

Fig. 4. The Learning Object Repository Interface.

In this project, the learning repository is accessed through a web service, allowing it to be consulted by the recommender algorithm, which is presented in the following section.

3.4 Recommender Algorithm

The algorithm for recommending learning objects to teachers in the Lesson Plan Platform makes use of several pieces of information coming from different sources, as detailed below:

1. The teacher creates a new lesson plan;
2. While teacher is editing his/herlesson plan, the Sobek mining tool extracts relevant terms from the text and returns them to the recommender algorithm;
3. The recommender algorithm searches for learning objects in FEB, based on the terms obtained from Sobek;
4. With these results, the recommender algorithm evaluates which of those objects are the most popular in Facebook, based on how many "like" ratings they have;
5. The history of similar objects that have been previously selected by the user and the similarity between the user profile and the learning object´s features are also considered in the object recommendation method;
6. The final set of selected objects is then informed to the teacher

In computational terms, this would be expressed as:

```
Read Keywords
If Keyword exists
So
{Query Repository(Keywords)
If exists results
So
    {
Whileexistsresults{
Query if object was already selected (idObject).
If object was already selected
So
Query similar objects (idObject)
Penalize object=1
If not
  Penalize object=0.1
End if
Obj_recommendation_val=ILIKE+Penalize object
}
End While
}
End if
Calculate Rob (Obj_recommendation_val, User_id)
Recommend Objects with higher Rob.
If not
No recommendations are made
}
If not
No recommendations are made

END
```

Equation 1 computes the general value for the Recommendation of a learning Object (Rob):

$$Rob = R(PC, IU, DO) \quad \textbf{(1)}$$

The value *Rob* is obtained from three variables: PC represents the keywords that a user enters when creating new content, IU represents the profile and interests of a user in particular and DO represents the description of the preferred object.

The PC value is obtained as follows (Equation 2):

$$PC = \forall H \ э \ H \max R \quad (2)$$

where the keywords of a text are taken from all concepts H that meet the maximum value of R. A concept H is a set of terms that a user incorporate to his/her lesson plan. R, meanwhile, is obtained with the help of the tool Sobek, defining a relevant term according to the following equation:

$$R = S \times C + F \quad (3)$$

where S represents a similarity coefficient of a concept in the text, C represents the number of terms of the concept and F the absolute frequency of each term.

Moreover, the UI value is obtained from the following equation:

$$IU = Usrio(DD + HS + HMG) \quad (4)$$

The user information variable is obtained from the sum of the values for certain criteria: some user demographics such as age and country of origin (DD), user history in the system (HS) considering number of courses created, topics of interest, among other information. Finally, the history of those user recommendations for an object expressed through "Facebook Like" (HMG).

The final computation of the preferred objects is obtained based on the following equation:

$$DO = Usrio(PC + POP) \quad (5)$$

where PC represents the number of keywords associated with an object that matches the information entered by the teacher and POP represents the level of popularity of that object in the social network Facebook. Both variables are represented by a numerical value so that their sum attributes a quantitative value to DO.

4 Case Study

This project proposed the incorporation of a recommender learning objects module to the-Lesson Plan e-learning platform, detailed previously in section 3.1. The proposal presented in this paper can be seen in Figure 5.

The recommender has as main objective that consists in collaborate with teachers generating lessons plans, offering them learning objects as they write the content. In this way, teachers can incorporate into the lesson plan created; links to learning objects related to the thematic treated enriching the content and literature of the lesson plan.

The recommender uses information from different sources:

- The e-learning tool "Lessons Plan" is where teachers create and view lessons plans. This tool provides information about the activities and actions being undertaken by the user.
- The "Sobek" tool from which, by applying techniques from data mining and artificial intelligence, keywords are identified and then used to recommend to the user, learning objects that can be incorporated as additional information.
- The social network Facebook to improve recommendations of learning objects taking into account the qualifications for a given object in this network.
- A repository of learning objects from which items to recommend will be obtained. The repository used is FEB, Learning Object Repository. Communication between the tool "Lessons Plan" and the repository is done using Web Services.

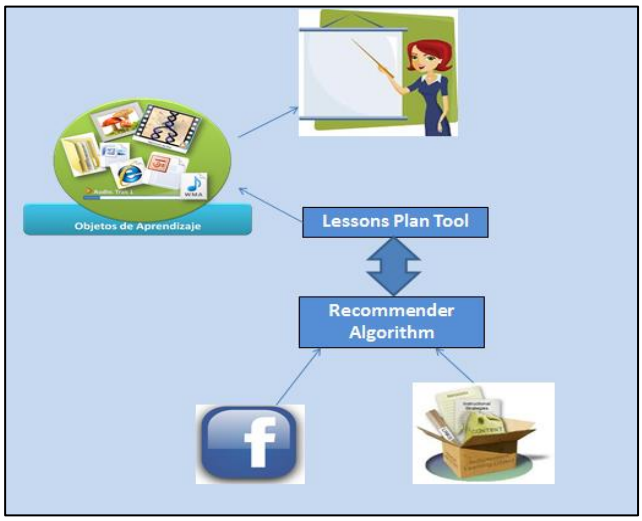

Fig. 5. Model of the system incorporated in the "Lessons Plan" tool.

Suppose, for example, that a teacher is writing a new lesson plan about computing´s history. One of the keywords entered by the teacher is the word “IBM”. Learning Objects with that

keyword are searched on FEB repository, obtaining two results: Object1 and Object2.The object´s metadata, the information structure that facilitate their identification, are this: the **title** that identify each object, the **keywords** that facilitate object's search, the **url** where objects can be located, and the **selected** value that take the number of 0 if that object has never been previously selected and the number of 1 otherwise. For this example, the object´s metadata are: Object1(title: "IBM 380"; Keywords: ibm, pc; Url: http://feb.ufrgs.br/feb/objetos/1155464, selected: 0) and Object2(title: "IBM in history"; Keywords: ibm-history; Url: http://feb.ufrgs.br/feb/objetos/1155475, selected: 0).

```
Read Keywords=IBM
If Keyword exists
So
{Query Repository("IBM")
If exists results(2)
So
    {
While_exists_results{
Iteration for Object1:
Query if object was already selected (IBM 380).
If object was already selected
If not
Penalize object1=0.1
Iteration for Object 2:
Query if object was already selected (IBM in history).
If object was already selected
If not
Penalize object2=0.1
```

As is showed in this recommender algorithm fragment, any object has been previously selected(cause the value of 0 in its metadata), so the "Penalize Object" value for both them is 0.1. Also, the number of Facebook Like of each object is search from its url. Object1, shown in figure 6, is the one that has more Facebook Like.

Fig. 6. Facebook Like for a learning object.

Table 1. Values for the variables taken into account by the recommender algorithm.

Object Title	*PC*	*IU*			*DO*		*Rob*
		DD	HS	HMG	PC	POP	
IBM 380	1	3	4	5	1	6	20.1

IBM in history	1	3	4	2	1	2	12.1

In particular, the values for HMG and POP variables are interesting. The first one shows that this user has liked objects similar to “IBM 380” more than objects similar to “IBM in history”. The second one, meanwhile, shows that object 1, “IBM 380”, is more popular because has more Facebook Like. Finally, as object1 has the greater Rob value, is the one that is recommended to the user. Figure 7 shows the interface of the tool “Lessons Plan” with the recommendations of learning objects received from the repository FEB.

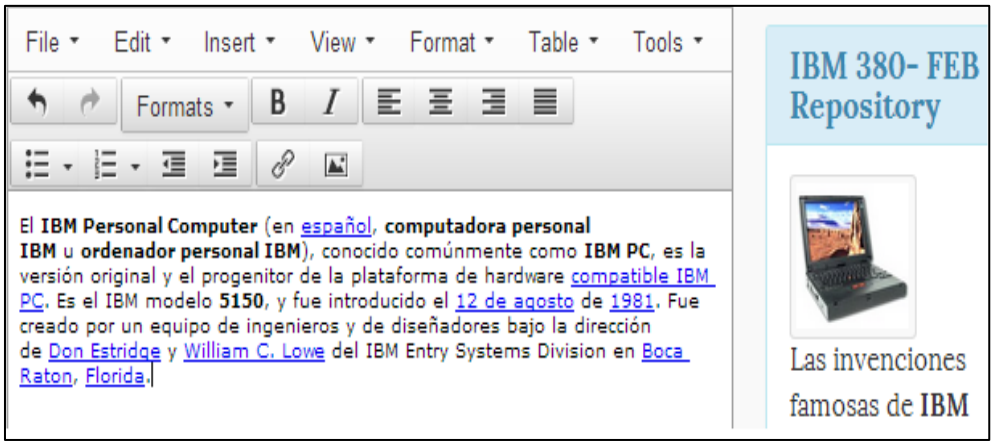

Fig. 7. Interface where the recommendations of items are made.

Teachers can share, discuss and LIKE learning objects recommended using Facebook as shown in Figure 8.

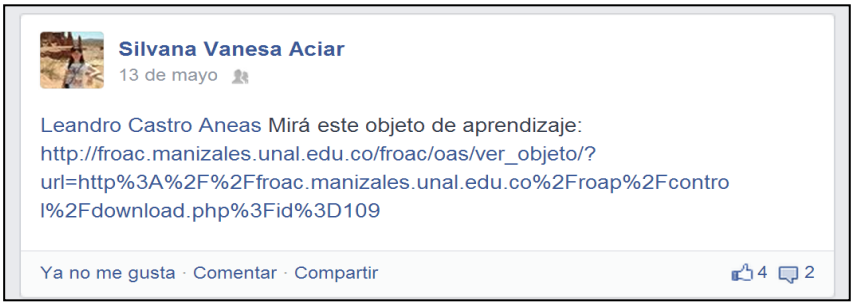

Fig. 8. Using Facebook to share learning objects.

Evaluations and comments from Facebook users to a learning object are then taken into account as a factor for the realization of the recommendations in the "Lessons Plan" tool.

5 Conclusions and future work

This paper presents the implementation of a recommender system of learning objects in a virtual learning platform. The recommendations are performed based on different criteria: similarity of the theme of an object that is being created with other objects stored in a repository,

assessment of users of the social network Facebook about a learning object, similarity of an object with many other objects previously elected by the teacher.

The contributions of this work are:

- Recommender system that takes into account the keywords of a lesson plan that is being created to recommend items related to it.
- A method to evaluate learning objects using social networks.
- A method of filtering information that takes into account the preferences and interests of users recommended, and also the opinions of others users based on social networks.

6 Acknowledgements

Special thanks to Guilherme Costa Severo and Octavio Acosta, researchers at the University Federal of Rio Grande do Sul and developers of "Lessons Plan" tool, who put at our disposal all the necessary materials to carry out this research.

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