

# Creating an E-Learning Recommender System Supporting Teachers of Engineering Disciplines

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**Abstract**—Numerous reviews and studies have shown that Learning Management Systems at university level often are lacking from a number of characteristics such as the support of various didactical approaches, the possibility to consider different specifics of engineering disciplines or a lecturer friendly interface. In this paper, a new recommender system is proposed for teaching staff of engineering disciplines; the novelty of the recommender system is that criteria used by the system are based on standards for engineering education in conjunction with the framework for pedagogical evaluation of Virtual Learning Environments. The suitability assessment scenario being suggested identifies the various needs of teaching staff member with regards to his/her course, teaching methods and also suggests tools that are necessary to increase functionality.

**Keywords**—*e-learning, engineering education, recommender system*

## I. INTRODUCTION

Several studies analysing the usage of Learning Management Systems (LMSs) by the teaching staff of engineering disciplines [1] have revealed problems such as the lack of collaboration among the lecturers in terms of the LMS usage and the lack of help available on the LMS usage. As a result, not all teaching staff members are going to use LMS in the near future.

The reviews of LMSs currently used at the University College of Borås/Sweden, Duke University/USA [2] and the University of Alberta/Canada [3] show that most universities often lack flexibility, interactivity and the possibility to take into account factors such as staff expertise and institutional needs. As a result, most of the times LMS does not permit the academic staff to exploit the education potential of state of the art E-Learning technologies. Therefore, universities sooner or later need to tackle the problem of moving their courses to another platform.

In conclusion, studies have shown that lecturers in general need more support when starting to use a LMS. Therefore, an appropriate recommender system that addresses the level lecturer expertise as well as the subject that he/ she is teaching is needed. Although the proper use of the LMS by students is another important aspect, the target audience of this article has been restricted to teaching staff of engineering disciplines.

The IMA/ZLW&IfU has almost forty years of experience in collaborating with the teaching staff of the engineering faculties of the RWTH in the area of developing better teaching approaches. Nowadays, more than eighty seminars aimed at the improvement of a teaching process are offered per semester. Therefore, our experience of communication with the teaching staff of the RWTH also has revealed the same drawbacks of LMSs which have been stated above and also found in studies. Furthermore, it has also been observed that local course websites and FTP servers are preferred over university LMS quite often. Some faculties are even known to have their own LMS.

Our goal is to create an E-Learning recommender system that can help teaching staff of engineering disciplines by providing recommendations on a selection of suitable E-Learning tools based on the criteria defined. The problem has been elaborated by using the framework for the pedagogical evaluation of virtual environments [5] in order to assess the needs of a teaching staff. Furthermore, the suitability assessment scenario for the recommender systems has been described and the as object diagram for future software engineering purpose has also been provided.

## II. BACKGROUND

### A. Theory

There is a commonly used division of E-Learning tools into Learning Management Systems (LMSs) and Course Authoring Tools (CATs). The E-Learning software overviews show that more than 400 LMSs and CATs are available [10]. Such systems require serious time investment in order to create the course and to educate at least one member of computer support on how to install and maintain the software [11].

A LMS provides mainly course management functionality and basic facilities of course authoring tools. For example, the most widely-used LMSs such as Moodle, Blackboard, Camillo and Sakai have a storage space, space for course description and Wiki as a tool for course contents. Course Authoring Tools provide to a course instructor functionalities to create an E-Learning content. Currently LMSs are much more adopted than CATs, although being only a part of wide E-Learning tools spectrum. Consequently, a lot of research about usage of LMSs is available.

The LMS/CAT division is sometimes problematic to apply in practice, for example Facebook, Twitter, Youtube do not perfectly fit into it, however these tools are included in the rating of top 100 e-learning tools [12]. These tools as well attract users with due to their ease of use and intuitive interfaces.

We will stick to more suitable for us classification of E-Learning Tools consisting of three levels [6]: the usage of internet, the usage of a platform and interactive contents. A „Level 1“ is achieved when internet is used, „Level 2“ is achieved when a platform and internet are used. A „Level 3“ is achieved when all three criterias have been fulfilled, i.e., the internet, a platform, learning videos, multimedia and interactive elements are used in E-Learning. For later scope of the article we will focus on „Level 3“. Scenarios corresponding to „Level 1“ and „Level 2“ are used for a long time at the RWTH, „Level 3“ scenarios such as MOOCs, Virtual Laboratories are now being introduced at a big pace [7], [8].

### *B. Vision*

The following working hypothesis is used for future work: „There are a number of well-defined and assessable criteria which assure the E-Learning tool suitability („Level 3“ according to the above classification) for a course and an institution once they have been applied systematically.”

Our goal is with regards to hypothesis to elaborate a number of criteria which assure the E-Learning tool suitability („Level 3“ according to above classification) for a course and an institution once they have been applied systematically.

The overall goal is to create a recommender system for the teaching staff which shall assist them in choosing appropriate tools with regards to engineering specifics. The system is aimed at all those individuals who wish to use E-Learning tools in their courses and it also takes into consideration the level of user experience.

General goal of the IMA/ZLW & IfU is to support the academic staff in using the „Level 3“ of the E-Learning tools hierarchy at the engineering faculties of the RWTH Aachen University. The specifics of various engineering education processes also needs to be addressed. However, it should be clearly stated that questions pertaining to the efficiency of the selected E-Learning tool in the learning process have been completely left out of the scope of our research.

### *C. Problem Elaboration*

According to the definition [9], „E-Learning is learning facilitated and supported through the use of information and communications technology (ICT)”. Consequently, both aspects of learning and of ICT tools need to be taken into account for criteria elaboration and consequently for creating the recommender system.

### *D. The framework for pedagogical evaluation of Virtual Learning Environments*

The framework for pedagogical evaluation of Virtual Learning Environments (VLE) is described in article [5]. VLE is a collection of tools enabling the management of online

learning, providing a delivery mechanism, student tracking, assessment and access to resources. VLE includes E-Learning tools therefore this framework is applicable to the scope of our work.

The framework is said to provide a clear set of requirements for evaluating the system's suitability for supporting the processes that form the basis of interactive learning. This framework is based on a system approach and therefore it has been chosen upon the other articles that were analyzing selected qualities of a learning process [13], [14], [15], [16], [17].

The framework combines a conversational model applied to the academic learning and a viable system model applied to the course management. Therefore „it helps in supporting pedagogical innovation (programme level), institutional management of programmes (module level) and students management of their own learning (learner level)”.

The criteria used by the framework for suitability evaluation are as follows: degree of presentation and re-presentation of key concepts and ideas, degree of coordination of people, resources and activities, resource negotiation and agreement monitoring of learning, degree of self organization amongst learners and the adaptability of the module and the system.

Therefore the novelty of the system lies in the following: explicitly defined audience, choice of pedagogically sound criteria that are used to assess E-Learning tools, the needs of a teaching staff member, his/her current scenarios in E-Learning tools usage.. and to suggest new tools, the scenarios and tools suggested will be based on the Engineering educational standards with regards to the subject specifics, therefore making the scenarios and tools suggested for the teaching staff member pedagogically biased, scientifically explained and compliant with the quality of course when based on engineering standard.

## **III. RESULTS**

### *A. Criteria profiling for engineering education*

The VLE framework has a universal character, therefore it can be used for engineering education. There are a number of standards of engineering education such as EC-2000 [18], CDIO [19], ABET [20], SPEC [21] that are used for the accreditation of engineering universities in the USA (ABET), UK (SPEC) and internationally (EC-2000, CDIO). These standards also serve as a basis for courses, goals identification, curriculum creation in the respective universities. We will stick to the CDIO standard and the framework criteria will be profiled according to the CDIO; this will be discussed later in the article.

### *B. Criteria Elaboration*

The main idea is to use the framework [10] and standards for engineering education in order to formulate criteria that shall be used to provide recommendation. These criteria are as follows: degree of presentation and re-presentation of key concepts and ideas, coordination of people, resources and

activities resource negotiation and agreement monitoring of learning, self organization amongst learners and the adaptability of the module and the system.

### C. Rationale towards the recommender system

Suitability assessment and evaluation can be automated therefore we suppose to build a recommender system software. Herein below the suitability assessment scenario for a recommender system has been suggested and explained (fig.1). To begin with, here are examples of questions from the framework that correspond to the „Programme level” and criteria “resource negotiation and agreement: “Does the system allow specification of programme rules for delivering a module? Does it permit or provide a space for negotiation etween programme managers and module tutor on resource questions? What tools does the system provide for teachers to present/express their ideas to students?”

Secondly, the CDIO standard imposes specific guidelines

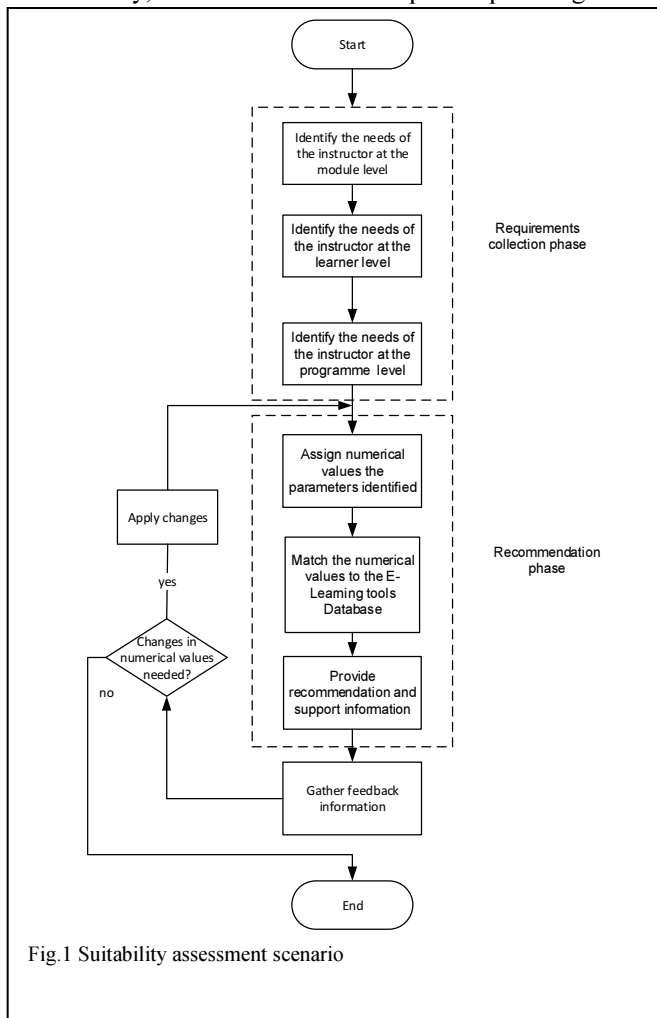


Fig.1 Suitability assessment scenario

which will shape the specifics of question. As a result, the VLE assessment will be superceeded with the CDIO assessment in applicable parts.

1) *Requirements collection phase*; From the criteria, a set of questions (similar to [22]) shall be formulated in order to identify the needs of the teaching staff member towards the E-

Learning tool at all three educational levels (module, learner and programme). As well his current experience with E-Learning tools will assessed basing on the VLE framework criteria. Every answer will be assigned with a specific score. In order to quantify the answers the recommendations of the CDIO standard will be used in applicable parts. Therefore all collected answers will be quantified.

2) *Recommendation phase*; A logical mapping between the needs of the teaching staff member identified and the criteria in evaluation framework is performed. Basing itself upon the values obtained for each criteria in a requirements collection phase the match to E-Learning tools database shall be performed. The E-Learning tools database will contain records for various E-Learning tools which are evaluated using the framework [6]. However, the benchmarking shall be used in order to have a score for each of the three levels (module, learner and programme). The tools included in the database will then be chosen based on tools ratings, engineering specifics and by making a questionnaire of the teaching staff. As a result, the relevant pieces of advice can easily be provided.

The exemplary representation of the E-Learning tools database is provided in the Fig. 2. Each of these tools have been added to the database are multiply assessed according to the criteria of the framework [6]. The criteria are contained in the left column of the table. Each criterion gives a score from 1 to 10 for the said tool. The scoring will be done on basis of expert interviews and by using the recommendations for benchmarking the E-Learning Tools in [21] . However, one must note that the content of the database provided in the Fig.3 simply aims at giving an idea of the inner view of the database; the scores themselves are not real.

The possibility of a feedback which may be needed when the instructors are not satisfied with the recommendation has also been well provided. The decision for changes can be made by a person after theprocessing of comments.

In the output screen of the system, the tool shall be suggested to the user and he/ she will have an opportunity to obtain more information about the tool itself; to understand the reason behind the recommendation and to correct the recommendation by adjusting the criteria according to his/ her personal feelings.

### D. The recommender system structure

A structural diagram (fig.4) illustrates the division of the system into the three layers: Representation layer, Business Logic Layer, Data Layer. Representation layer displays the information for users. Therefore, it consists of the database editor, the HTML Form Generator and the HTML Editor. The Business logic layer performs the logic calculations in the Recommendation phase with the help of a Recommendation Unit. The Data layer shall contain the E-Learning Tools Database that are to be used in Recommendation phase.

Criteria vs. Tool	Moodle	Blackboard	Twitter	Youtube	MS Word
<b>Module level</b>					
presentation and re-presentation of key concepts and ideas	10	8	6	10	8
coordination of people, resources and activities	10	7	10	1	8
resource negotiation and agreement	10	5	3	1	7
monitoring of learning	5	10	8	0	0
self organization amongst learners	10	10	8	0	0
adaptability of module and system	5	3	0	0	0
<b>Learner level</b>					
Learner-centredness	10	10	0	0	0
coordination of people, resources and activities	10	10	10	0	0
time management / planning	10	10	0	0	0
monitoring own learning	9	3	0	0	0
adaptation / reflection	7	10	0	0	0
<b>Programme level</b>					
Extensibility and integration	6	7	3	2	1
coordination of people, resources and activities	10	8	0	0	0
resource negotiation and agreement	10	8	0	0	0
monitoring of learning	10	8	0	0	0
self organization amongst learners	10	8	2	0	0
adaptability of module and system	10	8	0	0	0

Fig.2 E-Learning tools database

#### IV. CONCLUSION

The goal of this work was to address the problem of recommending E-Learning tools for a teaching staff of engineering disciplines by defining criteria that will be used to create an E-Learning recommender system.

The chosen criteria are based on the engineering standards of engineering education and the framework. The suitability assessment scenario for the recommender system has also been presented. The novelty of the recommender system lies in applying the framework to the engineering education, using the engineering standards to derive the questions for requirements collection phase and using the benchmarking of tools for the recommender phase.

The concept of the recommender system is presented at the early stages of system development. Therefore, future work must include a proper formulating of questions for the recommendation phase, the assignment and scoring of user answers and the careful benchmarking of available E-learning tools. A questionnaire of the teaching staff has also been planned. The questionnaire shall serve the following purposes: reveal new tools which should be included in the system, find out the various needs of the academic staff in the E-Learning tools and reveal the level of expertise of the teaching staff in terms of E-Learning tools usage.

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Criteria vs. Tool	Recommended
<b>Module level</b>	<b>Tool</b>
presentation and re-presentation of key concepts and ideas	8
coordination of people, resources and activities	8
resource negotiation and agreement	8
monitoring of learning	7
self organization amongst learners	10
adaptability of module and system	5
<b>Learner level</b>	
Learner-centredness	7
coordination of people, resources and activities	6
time management / planning	7
monitoring own learning	7
adaptation / reflection	7
<b>Programme level</b>	
Extensibility and integration	
coordination of people, resources and activities	8
resource negotiation and agreement	8
monitoring of learning	8
self organization amongst learners	8
adaptability of module and system	8

Fig.3 An example of the Recommendation Unit Output

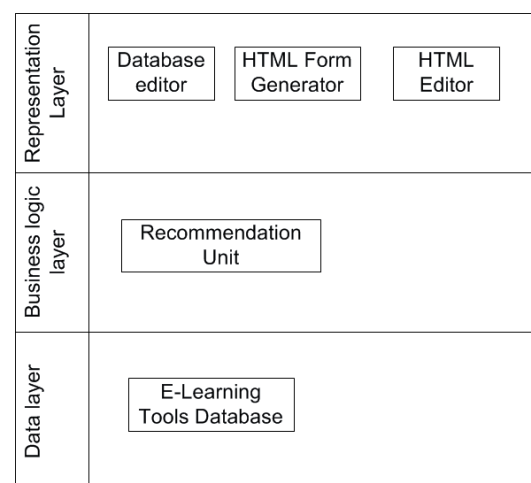


Fig 4. Structural diagram

EDUCATION : ABET , BLOOM ' S TAXONOMY , COOPERATIVE LEARNING , AND SO ON," 2004.

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