Personalized e-learning in Moodle: the Moodle_LS System

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Abstract

Learning Management Systems are among the most popular e-learning tools. Over the last few years, however, scientific research has made considerable progress in developing valuable resources currently unavailable in most Learning Management Systems, including solutions aimed at providing students with personalized support throughout the learning process, which is an essential requirement in continuing education. Observing and modelling the learner, and adapting their learning experience accordingly means opening up new technological and, above all, methodological perspectives in e-learning. The work described in this paper is part of the Open Learning project, in which business-based and university researchers aim to combine the most frequently used e-learning technologies, Learning Management Systems, with the benefits of customized systems so as to develop an innovative learning content delivery system based on the personalization

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of the learning experience. The proposed system integrates Moodle with an engine, LS-Plan, which provides automated sequencing of the learning material based on the learner's knowledge and learning styles. This paper describes the new system and presents the results of tests conducted in the domain of Italian Neorealist Cinema.

1 Introduction

While making the learning process free from space-time restrictions, Learning Management Systems (LMSs) offer students an active role in their own education: instead of just attending classes, learners can actively construct their own knowledge, enjoy considerable autonomy and choose to work collaboratively. Research in the field of e-learning focuses on the central role played by the student in the learning process: the personalization of the learning experience is closely related to the efficiency and effectiveness of the learning process itself, as personalized content is more easily assimilated by the learner who, as a result, is more strongly motivated. Nevertheless, the production and management of the learning material still require considerable effort on the part of the teachers. They are expected to plan their learning activities, produce e-learning content, manually sequence learning objects, and deal with standardization issues without losing sight of their primary objective: producing good quality learning material. Although quality can be improved by using previously adopted material, automated sequencing of the learning content for the definition of learning paths tailored to each student's needs is possible using intelligent tools and techniques (Brusilovsky & Millan, 2007).

The reference literature identifies two main families of e-learning systems: the popular and feature-rich LMSs and the prototypal and experimental systems developed by universities which are focused on personalization and provide learners with an intelligent support throughout their learning process.

The work described in this paper is part of the Open Learning project, in which public and private stakeholders contribute by their different expertise in education and learning to help e-learning providers improve their learning offer by adopting an innovative learning content delivery system centred on the personalization of the learning experience.

The purpose of this paper is demonstrating that one of the most widely used LMSs, Moodle (www.moodle.org), can be integrated with a form of customization by creating personalized learning content sequences based on the learner's knowledge and learning styles. Personalization is obtained by combining Moodle and the LS-Plan sequencing engine (Limongelli *et al.*, 2009) into a new system called Moodle_LS. Moodle was selected to develop a personalized LMS due to its modularity and extensibility as well as its vast community of users. In Moodle_LS, valuable support is provided to learners by creating

tailored courses, monitoring their progress and adapting their learning paths accordingly. LS-Plan was fully integrated into Moodle through the definition of new modules and a new course format: as a result, users are offered this new service within Moodle itself with no need for them to use a different environment. Support for teacher comes in the form of automated sequencing of the content delivered to the students.

Section 2 describes the state of the art in e-learning systems outlining advantages and shortcomings of both LMSs and the prototypal systems developed by universities. Section 3 explains how LS-Plan was integrated into Moodle while section 4 shows how the new system, Moodle_LS, could be used, for example, in an experimental course on Italian Neorealist Cinema. Finally, conclusions are presented in final section.

2 State of the Art

2.1 Personalization

Web-based systems are increasingly focused on personalization: whether it is search engines, e-commerce sites or learning systems, attention is always on the user, who is observed, modelled and supported accordingly so as to meet their needs (Brusilovsky & Millan, 2007). Intelligent systems allow user modelling and can be adapted to the user's needs. Several methods have been proposed for modelling students and offering them personalized learning activities (De Bra *et al.*, 2006; Sangineto *et al.*, 2008; Weber & Brusilovsky, 2001). A frequently proposed personalization technique is Course Sequencing, in which the learning activities which make up a course, are sequenced based on key information about the student (Brusilovsky & Vassileva, 2003). Intelligent Tutoring Systems were developed and applied, for example, to geometry or physics education (Anderson *et al.*, 1995), as well as several Adaptive Educational Hypermedia (AEH) using both Adaptive Presentation to adapt the content of a page, based on the student model, by inserting, changing and hiding specific fragments of text and Adaptive Navigation Support to adapt link presentation (and support the student's navigation) through annotation, sorting and hiding techniques (Brusilovsky & Millan, 2007). The learner's most observed and modelled characteristic is her knowledge about the learning domain, as assessed through quizzes or usage-based information. Some systems are based not only on modelling of the student's knowledge, but also on their learning styles, as modelled through specific tests and, if necessary, updated on the basis of their progress (Alfonseca *et al.*, 2006; Sangineto *et al.*, 2008). By modelling the learner, learning systems can adapt content to the individual user's actual needs.

2.2 LMS Personalization

Despite being the most popular learning systems, LMSs provide limited or no support for personalization. The SCORM standard (http://www.adlnet.gov), especially its 2004 version, makes it possible to differentiate the Learning Object (LO) sequence introducing a set of rules which can be defined by the instructional designer. At present, this standard is not supported by all LMSs and the definition of the sequencing rules is quite complex. Other LMSs, such as Intelligent Web Teacher (Sangineto *et al.*, 2008) and Alfanet (Santos *et al.*, 2004), integrate the concepts of student modelling and personalization, but are not yet widely used. On the other hand, one of the most popular and frequently used LMSs, Moodle, offers limited support for personalization: in terms of user interface, it is possible to personalize the environment by creating new themes, and, in terms of features, users can add a number of plug-on available on the Moodle official website; however, from a methodological point of view, its potential in personalization is limited. The 2.0 version of the platform gives teachers more flexibility in the definition of alternative learning paths: the so-called Conditional Activities. In other words, specific activities can be made available to the learner according to certain conditions, such as the grade obtained in one or more tests, the completion of one or more activities, or a combination of the two. Teachers, however, remain responsible for defining possible alternative learning paths.

3 Moodle_LS

3.1 LS-Plan

The LS-Plan personalization engine dynamically adapts the course to the student's needs. LS-Plan adopts a three-step approach: i) modelling the learner according to her knowledge and learning styles ii) producing a personalized course and iii) adapting the course throughout the learning process based on the learner's progress and difficulties.

The learner's knowledge of the course topics is assessed through a pre-course test. Their learning styles are described using the Felder-Silverman model (Felder & Silverman, 1988) in which four dimensions (d1=active/reflective, d2=sensing/intuitive, d3=visual/verbal, 4=sequential/global) are assigned values on a -11 to +11 scale to define the learner's preferred learning style. This model was selected because: it represents a combination of other models, such as the Kolb (Kolb, 1984) and Pask (Pask, 1976) model; provides a numerical evaluation of learning styles which proves especially helpful when used with automated systems; its validity was successfully confirmed in (Zywno & Wa-

alen, 2001).

Personalization, however, requires a good deal of work. Teachers are expected to associate each Learning Object (LO) with the prerequisites needed for its study and the knowledge acquired through its use. Teachers are also required to indicate the approximate time needed to study each LO and the appropriate learning style to adopt according to the Felder-Silverman model. A LO can be more verbal than visual, or more practical than theoretical and yet deliver the same concept. This characterization is closer to the teacher's way of thinking and enables them to implement different strategies by providing, for example, alternative LOs to students with different learning styles.

This system can design a personalized course according to the initial student model and the use of metadata by teachers to manage learning content. The student is monitored through in-course assessment of their progress and actual usage of the learning material, which enables the system to adapt the course to the student's needs.

3.2 LS-Plan in Moodle

LS-Plan is integrated into Moodle in such a way that its integration is transparent to users (teachers or students) who can navigate through the LMS using a new course format and new activities. Adherence to Moodle's logic is, therefore, strong: the activities and questionnaires presented to the student are taken from Moodle and the personalization logic is developed in a new course format. The integration of the LS-Plan personalization engine is illustrated in Fig. 1 where both the features added to Moodle (on the left) and those which constitute an integral part of LS-Plan (on the right) are shown in black.

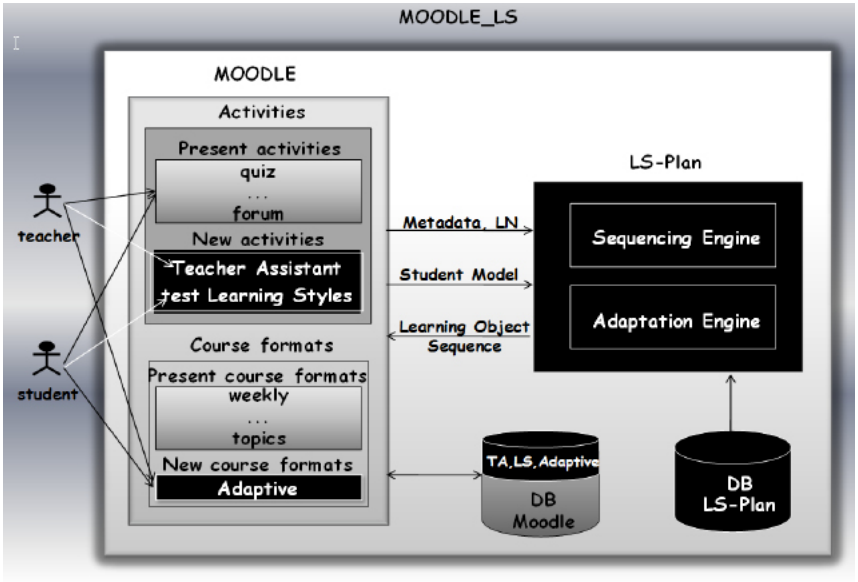

Fig. 1 - Moodle_LS

Features added to Moodle include the Adaptive course format and the following modules:

- Teacher Assistant: this module (Fig. 2) enables teachers to associate LOs with the information required by the personalization engine. It is transparent to the user.
- Test Learning Styles: it provides users with a link to the Felder-Soloman test which determines the four values representing the student's learning styles. Once they have completed the test, students can use this module to feed the obtained results into the system.

These new modules and course format interact with LS-Plan. More specifically, the sequencing engine part configures the initial LO sequence, while the adaptation engine part selects the most appropriate material for each learning style. LS-Plan also features a database for storing information concerning all Moodle activities, the student model, which includes knowledge acquired (or lost) throughout the course, and the student's learning style which depends on their successful study of specific LOs (Limongelli *et al*.,2009).

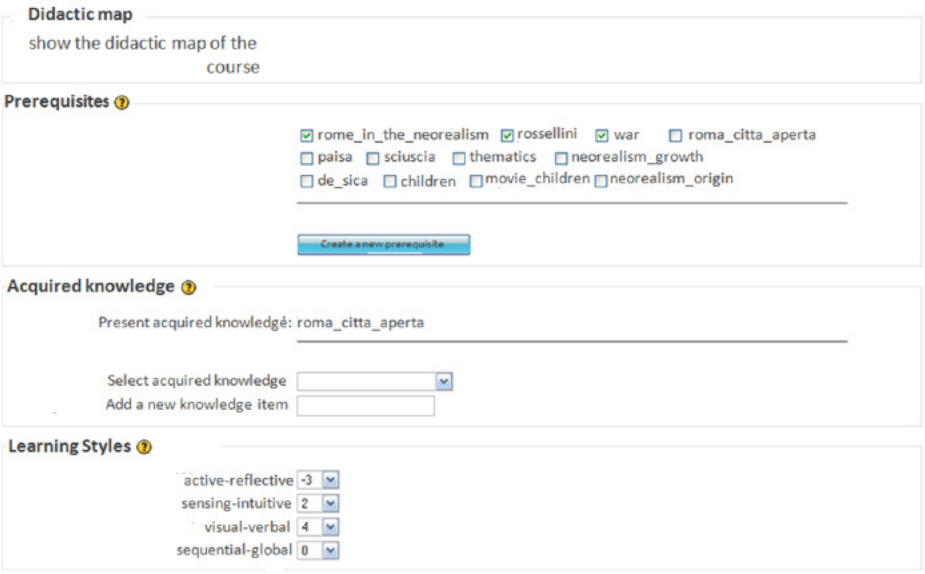

Fig. 2 - The Teacher Assistant module: selecting the prerequisites, acquired knowledge and learning styles for which the material is most suited.

Teachers can create a personalized course by designing a new adaptive course format: in terms of interface, this is similar to the topic course format and will be structured by defining the learning material, relevant tests and a hierarchy of LOs, i.e., prerequisite relations, through the Teacher Assistant module. The system will use this information to create customized courses according to the learner's characteristics: each student joins the course, selects her own learning styles according to the Felder-Silverman model and takes a preliminary test aimed at identifying pre-course knowledge of the course topics. This information is used by the personalization engine to define the initial student model and shape the course accordingly by generating a sequence of LOs consistent with the hierarchy defined by the teacher and including those very objects which best suit the student's learning styles. The student will eventually follow the course going through its LOs and taking all relevant tests. The system will take into account the student's performance in the tests and navigation patterns to adapt the course using appropriate messages to guide them. Should the student struggle to pass the test designed for a specific LO, the system will propose alternative LOs, if any, or suggest that the preliminary LOs be revised.

4 Example of Use

This section illustrates how the system can be used in a course on Italian Neorealist Cinema. Once the teacher has identified the course content, the system shows the prerequisite relation graph, as illustrated in Fig. 3. The same concept can be delivered using different learning styles. For example, the concept related to the movie *Roma Città Aperta* is delivered using three different learning styles represented by LOs id2, id3 and id19.

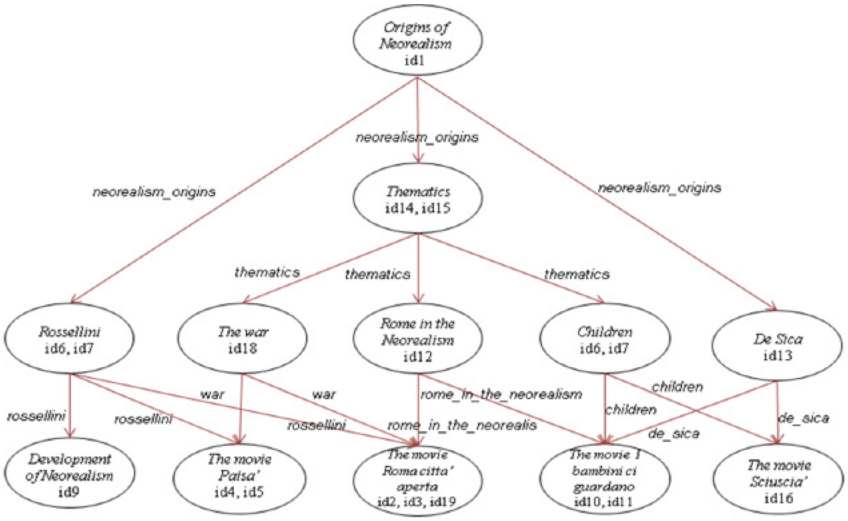

Fig. 3 - Graph showing prerequisite relations for a course on Neorealist Cinema. Nodes represent the concepts delivered in the IDs. If more than one ID is displayed in one node, the same concept can be delivered using different learning styles. Incoming arcs indicate the prerequisites, and outgoing arcs indicate the acquired knowledge.

Suppose that student S1 has no previous knowledge of the course topics, while student S2 already knows neorealism_origin, thematics, rossellini, children, sciuscià, de_sica. The courses produced for each of them will be structured as follows:

S1: id1-Origins of Neorealism, id14-Thematics, id12-Rome in the Neorealism, id7-Rossellini, id18-The war, id2-Roma Città Aperta, id5-Paisà, id8-Development of Neorealism, id13-De Sica, id17-Children, id16-Sciuscià, id10-I bambini ci guardano.

S2: id12-Rome in the Neorealism, id18-War, id19-Roma Città Aperta, id4-Paisà, id8-Development of Neorealism, id11-I bambini ci guardano.

If the same concept is delivered in more than one LO (e.g., id4 and id5 for

the movie *Paisà*), the system will select the LO which best fits the student's learning styles, that is the one whose metadata are the closest to those learning styles according to the Euclidean metrics. The course is first personalized based on two parameters: the student's pre-course knowledge and their learning styles. During the course, and on the basis of the student's performance in tests taken at the end of each learning unit, LS-Plan will adapt the course itself to respond to possible significant changes in the student model. This example was meant to give a general idea of how the system works. The Moodle_LS system is currently undergoing extensive testing. The LS-Plan personalization engine, however, has already been thoroughly tested and integrated into a prototypal LMS. During testing, a group of students was offered a personalized course, and another group followed the same course in non-personalized mode: on average, the increase in knowledge was 26% higher in the first group than in the second group. A detailed description of the test and additional information obtained from its results is available in (Limongelli *et al.*, 2009).

Conclusions

This paper proposed the integration of the LS-Plan personalization engine into a popular LMS, Moodle, to form an extended version of Moodle which was called Moodle_LS. The proposed integration aims to combine the benefits of little-known university-developed personalized systems with LMSs which, despite lacking almost any form of personalization, are widely used and feature specific tools for supporting teaching activities and collaborative learning. LS-Plan is fully integrated into Moodle and makes the best of its extensibility and modularity. Specific tools help the teacher use metadata to manage their learning material and provide automated sequencing of the course content for each student. Teachers can, therefore, focus on developing the general course and on content production. This solution is still in the experimental stage, but the benefits of the proposed personalization have already been confirmed by a number of tests.

REFERENCES

Alfonseca E., Carro R. M., Martin E., Ortigosa A., Paredes P. (2006), *The impact of learning styles on student grouping for collaborative learning: A case study*, User Modeling and User-Adapted Interaction, 16(3-4), 377-401.

Anderson J. R., Corbett A. T., Koedinger K. R., Pelletier R. (1995), *Cognitive tutors: Lessons learned*, J. of the Learning Sciences, 4(2), 167-207.

Brusilovsky P., Millan E. (2007), *User models for adaptive hypermedia and adaptive*

educational systems, in: Brusilovsky P., Kobsa A., Nejdl W. (eds), The Adaptive Web: Methods and Strategies of Web Personalization, LNCS 4321, 3-53, Springer.

Brusilovsky P., Vassileva J. (2003), *Course sequencing techniques for large-scale web-based education*. Int. J. of Continuing Engineering Education and Life-long Learning, 13, 75-94.

De Bra P., Smits D., Stash N.(2006), *Creating and Delivering Adaptive Courses with AHA!*, in: EC-TEL, 21-33.

Felder R. M., Silverman L. K. (1988), *Learning and teaching styles in engineering education*, Engineering Education, 78(7), 674-681.

Kolb D. A.(1984), *Experiential Learning: Experience as the Source of Learning and Development*, Prentice-Hall.

Limongelli C., Sciarrone F., Temperini M., Vaste G. (2009), *Adaptive learning with the LS-Plan system: a field evaluation*, IEEE Transactions on Learning Technologies, 2(3), 203-215.

Pask G. (1976), *Styles and strategies of learning*. British Journal of Educational Psychology, 46, 128-148.

Sangineto E., Capuano N., Gaeta M., Micarelli A. (2008), *Adaptive course generation through learning styles representation*, Universal Access in the Information Society, 7 (1), 1-23.

Santos O. C., Barrera C., Boticario J. (2004), *An overview of Alfanet: An adaptive iLMS based on standards*, in: Proc. of Int. Conf. on Adaptive Hypermedia and Adaptive Web-Based Systems, LNCS 3137, 429-432, Springer.

Weber G., Brusilovsky P. (2001), *ELM-ART: An adaptive versatile system for web-based instruction*. Int. J. of Artificial Intelligence in Education, 12, 351-384.

Zywno M. S., Waalen J. K.(2001), *The effect of hypermedia instruction on achievement and attitudes of students with different learning styles*. In Proc. Annual ASEE Conf.