Helping Teachers to Track Student Evolution in a B-Learning Environment

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Abstract

SigMa is an adaptable feedback generation tool for the three kinds of actors involved in a blended-learning process: teachers, students, and the e-learning platform. This paper focuses on the teacher tool and defines its desirable functionalities and main components. The teacher tool gathers data provided by the e-learning platform’s diagnostic capabilities and analyses it. The results are shown to teachers by means of a Visualisation Interface that informs them about course development and suggests possible changes and improvements. A Teacher Profile is used to adapt the feedback to match teachers’ strategies and preferences.

1. Introduction – MAGADI

During the past few years, the blended-learning (b-learning) approach has promoted the combined use of face-to-face (classic) learning and e-learning systems. MAGADI [1] is an environment built on this premise, and its main aim is to provide a rich set of functionalities useful for overall learning. Overall, in this context, means to handle several subjects simultaneously—for instance, all of the courses a university student is enrolled in.

MAGADI is an open, domain-independent and adaptive platform that provides mechanisms for integrating online and offline activities. It contains information about the set of subjects studied by a student, including inter- and intra-domain issues. Additionally, a general model for each student tracks learning characteristics and behaviour related to all subjects in which she is enrolled; it also allows records of a student’s inter-subject skills to be kept.

In this kind of environment, face-to-face (F2F) interactions are usually interleaved with online sessions. This results in changes to student knowledge that teachers should take into account in order to adjust both their learning strategies and the online system’s adaptation mechanisms. For example, the results of online activities should be available to teachers in order to prepare the next F2F interaction, while the results of the last F2F session ought to be included in the online system so they can be taken into account in subsequent interactions. Therefore, teachers need to monitor all the online students’ results; at the same time the system needs to know how student knowledge evolves due to external activities. SigMa, a feedback tool incorporated into MAGADI, is our proposal for tackling these issues.

This paper is organised as follows. Section 2 explains SigMa’s conceptual basis. Section 3 describes SigMa’s teacher tool, its analysis component, the teacher profile, the visualisation requirements and a working example. Finally, Section 4 draws some conclusions and points towards future lines of research.

2. SigMa’s conceptual basis

Our working hypothesis for SigMa is that the study of interactions among all the educational actors can be used to discover difficulties, desires and strategies which can be useful for improving the overall teaching/learning process. This hypothesis is confirmed by everyday teachers’ experience, where they consider F2F interactions the primary basis for their conclusions about students’ learning processes.

Therefore, SigMa’s conceptual baseline consists of gathering relevant data from interactions among the actors involved in the overall learning process supported by MAGADI, analyzing them and providing pertinent advice to each actor about ways to improve the educational experience.

Figure 1 shows the typical actors involved in blended environments: student(s), teacher(s) and the online environment (MAGADI). Interaction lines 1 and 2 involve MAGADI and the student or teacher; line 3 corresponds to classic interactions.
MAGADI collects interaction data coming from interaction lines 1 and 2. Data from student/MAGADI interactions (line 1) are collected when free or guided online learning sessions are in progress (e.g. reading documents or carrying out learning activities). Information about teacher/MAGADI interactions (line 2) is gathered during the authoring and analysis sessions, when student model modifications or personalisation’s preferences adjustments are being carried out. Finally, the relevant information regarding teacher/student interactions (line 3) that comes from F2F sessions or tutorships is recorded directly and explicitly by teachers. All interaction data are stored in the MAGADI databases.

SigMa provides each actor with different functionalities and interfaces. Teachers are provided with a help mechanism which detects students or subject resources that show undesirable behaviours. In addition, they can visualize the information about their students (or group of students), such as their learning progress, activities and behaviour with the online environment, and comparative results of students belonging to a group.

Students can check learning activities they have completed and the results, together with the learning progress made in each subject. These functionalities are obtained by opening the student model [2], and they allow reflection on learning as they point out mistakes, weak concepts and time spent for each subject, among other things.

Finally, SigMa results are considered in the MAGADI recommendation processes that are carried out either at the beginning of online sessions or during the guided sessions. So, as MAGADI databases are enriched with learning information derived from external (not online) interactions, its adaptation to the student becomes improved with the personal view of the human tutor.

3. SigMa for Teachers

Considering our working hypothesis (section 2), the purpose of SigMa’s Teacher Tool (STT) is to provide teachers with information about their students’ learning processes that is very difficult or time-consuming to obtain by other means. This information ought to be useful for improving the teaching task and also for facilitating coordination between online and offline student learning activities. In this sense, SigMa keeps teachers up to date with their subjects and their students’ evolution and makes their workload lighter.

As the b-learning approach demands a continuous and cohesive learning process, a tight link between the learning strategies selected by the teacher and those used by the MAGADI platform must be imposed. This is only possible when the teacher and the platform share the same beliefs about the students’ characteristics and knowledge status. So, STT helps teachers to discover differences in beliefs as well as to find and solve the underlying anomalies in order to arrive at a common base.

But what kind of information do teachers look for in their students’ development? Although every teacher seems to show different needs depending on his subject, studies along this line (see section 3.1) show that it is possible to establish a set of common requisites. In addition, we have interviewed several teachers from the School of Computer Science at the University of the Basque Country (EHU) to detect and compare the needs that have arisen from their positive and negative experiences with the EKASI and Moodle e-learning platforms (both regularly used at EHU). Findings point out three main things teachers look for: learning characteristics of individual students, results obtained in developing learning activities and learning concepts, and global behaviour/characteristics of groups of students.

A general architecture was defined based on these premises [3]. It consists of a Visualisation Interface (VI) which is supported by an Automatic Analysis Module (AAM) and whose behaviour is adapted to the user’s needs represented in the Teacher Profile (TP) (see Figure 2). Additionally, a Data Acquisition Module (DAM) was included in order to extract and categorise the relevant information from MAGADI databases. The VI shows the data collected from online learning resources used by students, results of learning activities, and selected aspects of MAGADI’s student models and then analysed. To facilitate the exhaustive checking of student models, the AAM focuses the teacher’s attention on the areas where he can find problematic situations related to students or subject topics and give him some suggestions about how to handle the detected trouble areas.

Finally, with respect to individual requirements, STT can be configured depending on teacher strategies and preferences. Thus, it models the teacher (TP) and adapts its analysis behaviour and appearance to match the teacher’s characteristics.
Next, each module and its application characteristics are explained.

![Figure 2. SigMa Teacher Tool architecture](image)

### 3.1. Analysis Module

EHU teachers’ needs mainly match those described in [4, 5]. The surveys carried out in these papers questioned teachers and instructors of distance courses about the information they considered relevant for their teaching purposes. Three main purposes appeared: “to identify and remedy common error misconceptions”, “to adapt teaching to individual students and groups” and “to respond to specific individuals in an appropriate way”. In fact, they were trying to discover in their students’ behaviour situations they were already aware of and for which they could develop appropriate teaching actions. Teachers do not search for abstract patterns in the data and then try to discover what their meaning is. On the contrary, they try to find concrete empirical patterns with a clear meaning.

Thus, with the aim of detecting clear patterns, the analysis module calculates global statistical values and searches for association rules in the information collected in MAGADI; then it analyses and interprets the results by recognizing several types of patterns. In addition, the analysis produces a set of notices that informs teachers about course development and suggests a set of possible changes and improvements. The selection of data and calculated values is described in depth in [3] and match those in [4].

A collection of patterns was defined after interviewing EHU teachers. The patterns are related to the three aforementioned areas, i.e. individual student behaviour, global behaviour of groups, and domain component behaviour, and they are divided in two granularity levels: learning activities and concepts. Patterns related to concepts look for concepts that are difficult for the students; patterns associated with learning activity results look for anomalous student results according to the teacher’s point of view (a high number of failures, too much time spent on an activity, a high abandonment rate, etc.).

A behaviour pattern is defined by three attributes: a list of conditions describing a concrete anomalous situation, a textual explanation, and a suggestion to correct the undesirable detected behaviour [3]. This definition is combined with the teacher profile to generate a personalised search. Table 1 shows some learning activities and concept-related patterns.

#### Table 1. Behaviour patterns

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Explanation</th>
<th>Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 1</td>
<td>The activity is abandoned by a high number of students and the ones who have solved it have failed.</td>
<td>Check if the activity difficulty level is appropriate for the current students. Check the activity definition.</td>
</tr>
<tr>
<td>Conditions list:</td>
<td>-Abandoned percentage $&gt;$ Abandonedt threshold</td>
<td></td>
</tr>
<tr>
<td>P 2</td>
<td>A high number of students have passed the activity and usually in less time than estimated.</td>
<td>The activity is very easy for the students, reduce its assigned difficulty level.</td>
</tr>
<tr>
<td>Conditions list:</td>
<td>-Passed percentage $&gt;$ Passed threshold</td>
<td>-If the rule is present: Solution.Correct $=&gt;$ TimeSpent.SHORT</td>
</tr>
<tr>
<td>P 3</td>
<td>The concept has not been completely covered by any student, despite some of them having passed it.</td>
<td>Check if there is enough learning material related to the concept</td>
</tr>
<tr>
<td>Condition list:</td>
<td>-Concept_incomplete_percentage $&gt;$ Concept in incomplete threshold</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Concept passed percentage $&lt;=$ concept passed threshold</td>
<td></td>
</tr>
</tbody>
</table>

When a particular behaviour pattern is found, a notice is triggered. A notice cites a particular predefined behaviour pattern for a particular teacher, a data range and the current date (see Figure 3). As notices are related to individual teachers, they are stored in the Teacher Profile. Each notice can be in one of four states:

- **New (not seen)**, generated by the system but the teacher has not read it yet;
- **Seen**, it has been read by the teacher (it is not new) but he has not decided yet whether it is relevant or irrelevant;
- **Relevant**, the teacher has acted upon the notice or found it useful;
- **Irrelevant**, the teacher decides that the notice is irrelevant or not useful.

Although irrelevant notices are not shown to teachers, they are not removed from the system. Thus, the utility of the notices and the actions taken after their visualisation can be subsequently analysed to improve the AAM or help teachers to personalise their patterns. Since the number of notices can be large, a cluster mechanism groups and generalises similar notices. This allows several notice levels to be established: individual, group and whole-class.
3.2. Teacher Profile

The teacher profile contains a set of visualisation preferences, a set of thresholds (e.g. the percentage of failed students that is considered common for a subject) and a collection of behaviour patterns used for the automatic analysis. Thus, the profile stores teachers’ personal preferences for analysing the interactions recorded in MAGADI as well as for visualizing the resulting analysis. As a teacher can have different standards for each subject and academic year, there is a General Teacher Profile (GTP) that can be refined for each subject/year combination. The GTP is created with statistical averages as default values and a collection of basic behaviour patterns which can be modified by the teacher anytime.

The status of behaviour patterns can be “active” or “inactive” (ON, OFF) in order to provide more flexibility to the STT and adapt the analysis results to the teachers’ expectations. Teachers will be always informed about the patterns used to create each system notice. Figure 4 shows the GTP (A) and a profile for a subject (B). In (B), two threshold values are changed, and some of the general patterns (Table 1) have been deactivated and a new one has been added.

3.3. Visualisation Interface

State-of-the-art work on the visualisation of learning show several tools that help teachers to visualize the evolution of their students [6, 7], combine visualisation information with data analysis [8], and provide feedback for teachers and students [9]. However, few proposals merge all these aspects to present an unified answer to teachers’ needs. Our contribution in this aspect consists of combining, in the same Visualisation Interface (VI), a set of functionalities that allow teachers cohesive and integrated use of b-learning systems; this combination covers the teacher’s needs when they deal with their students and subjects.

The VI is organised around three areas: domain elements, student behaviour and student group behaviour (see Figure 5). Each of them shows adapted advisory notices generated by the AAM, and general evolution data.

The domain elements area shows the existing resources according to their granularity (concepts, learning activities, texts, etc.) extended with information about level of use, student’s knowledge level (on average), times tried, and so forth. We are considering adding other visualisation schemas’, e.g. bar charts, combined charts, etc. Figure 5 shows the learning activities view with a notice related to the selected activity, whose question is also shown to make it easier to recognise it.

The individual student’s area opens MAGADI’s student model to the teacher and enriches it with the results of the AAM. It includes the mark obtained, time spent and mistakes made for every learning activity completed, the knowledge level acquired for each domain concept, when the course was accessed and a list of mistakes made. In addition, the whole-class value average will be shown together with the individual values to facilitate the teacher’s work comparing students progress.

The SMILI [2] framework defines seven general purposes for opening a student model. We rely on this framework, though at the moment only three aspects are required in this context: “instructor reflection”, “help plan/monitor” and partially “control and trust”. The model properties taken into account are accessibility extent, access to the source/s of data input, presentation type (overview-detailed), access method and initiative, consequences of the model for personalisation, and the role of time. So far, the first four have been integrated into the current prototype while the last two will follow in subsequent versions.

The student group’s area resembles the individual student’s area, but the values shown are compiled from the individual models belonging to group members.
4. Conclusions

In this paper we have outlined the MAGADI blended learning platform and its main characteristics. A reflection on the blended approach and its different kinds of interactions have driven us to identify teachers’ needs when they try to tightly integrate several learning systems in order to improve the students’ learning process. As a consequence, we proposed the SigMa Tool, we defined its conceptual base and we focused on its aspects with regard to the identified teachers’ needs.

The initial prototype covers the complete proposed architecture, even though the set of functionalities is restricted. The prototype provides three main functionalities: (a) notices about the learning activities executed and the visualisation of each activity solved with students’ answers, (b) a visualisation of the student model with associated knowledge levels for each subject topic and (c) a visualisation of the student work organised by date.

A first prototype evaluation was undertaken at the EHU School of Computer Science, with two small groups of students from the courses “Introduction to Programming” and “Databases”. The goal was to collect the teachers’ initial opinions, criticisms and perceived advantages regarding the prototype’s usability and provided functionalities.

Two main weaknesses in SigMa were pointed out by teachers: (a) accuracy of control over the patterns and (b) other sources of information, such as statistical values or charts, which would allow teachers to get a better picture of the students’ work in order to check the notices provided more easily. Both criticisms arose from the teachers’ desire to fine-tune the patterns themselves. Although the functionality of seeing the students’ work organised by date was positively evaluated, teachers asked for it to be widened in order to have a general view of the class’ progress by providing access to the entire set of class activities arranged by date.

As regards usability, teachers demanded explanatory texts and a re-organisation of the access to the different options to cope with increasing functionalities. These comments and improvement requirements are being included in the current version of the system. An in-depth evaluation test will be conducted in 2009. A formative and exhaustive evaluation will be carried out in order to determine the utility of the combined use of the open learner model and the automatic analysis, as well as to learn about the teachers’ judgment regarding each piece of information and their difficulties in using the tool.

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5. References