Uso de validadores de código integrados en Moodle como apoyo al aprendizaje de programación web


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RESUMEN
Las nuevas metodologías de educación demandan incorporar procesos de enseñanza-aprendizaje que cumplan con las necesidades e intereses de los alumnos y que se adapten de forma coherente al resto de los procesos existentes. En este sentido, la incorporación de nuevas actividades específicas de la temática correspondiente a la plataforma de e-learning Moodle proporciona ese valor añadido que se promueve a la vez que permite su uso de forma integrada en el entorno de aprendizaje. Siguiendo esta premisa, se han desarrollado aplicaciones Moodle para la validación de códigos JavaScript y PHP que permiten mejorar el aprendizaje en asignaturas relativas a la programación de aplicaciones web. Estas aplicaciones ofrecen información al alumno sobre los errores cometidos y las diferentes palabras clave del lenguaje. Además de estas facilidades de aprendizaje, las herramientas recopilan información sobre los tipos de errores que comete cada alumno, de modo que el profesor pueda observar de forma gráfica qué conceptos son más problemáticos para los alumnos. El empleo de estas aplicaciones durante el curso 2010-2011 en la asignatura Aplicaciones Telemáticas Multimedia se ha valorado como muy positivo tanto desde el punto de vista del alumno como desde el profesor.

Palabras clave: Moodle, validadores de código, programación web, JavaScript, PHP
Using code checkers integrated in the virtual e-learning platform Moodle to support the learning of web programming


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ABSTRACT
New methodologies in education demand incorporating teaching-learning processes complying with the requirements and interests of students and coherently adapting the existing processes. In this sense, developing new activities focused on specific themes for the e-learning platform Moodle, provides the added value promoted along with an integrated use in the learning environment. Basing on this assumption, Moodle applications for checking JavaScript and PHP codes have been developed, allowing to improve the learning process in web programming university courses. These applications offer the students information about the committed errors and about the keywords of the programming language. Moreover, they also gather information about the type of errors committed by each student so as the teacher can graphically observed which concepts are problematic and need to be clarified. The use of these applications in the course named “Aplicaciones Telemáticas Multimedia” has been appraised as very successful from the standpoint of both the students and the teacher.

Keywords: Moodle, code validators, web programming, JavaScript, PHP
1. INTRODUCTION

“Education and Training 2020” (ET 2020) is a new strategic framework for European cooperation in education and training that builds on its predecessor, the “Education and Training 2010” (ET 2010) work programme. “Education and Training 2020” (European Union, 2009) emphasizes that education and training have a crucial role to play in meeting the many socio-economic, demographic, environmental and technological challenges facing Europe and its citizens today and in the years ahead. Efficient investment in human capital through education and training systems is an essential component of Europe's strategy to deliver the high levels of sustainable, knowledge-based growth and jobs that lie at the heart of the Lisbon strategy, at the same time as promoting personal fulfillment, social cohesion and active citizenship.

“Education and Training 2020” states four common strategic objectives for Member States, one of which is “Improving the quality and efficiency of education and training”. The team involved in the present work takes special attention to this strategic objective, and considers that in order to improve the quality and efficiency of education and training, it is necessary to count with tailored tools that can provide adequate solutions to specific learning scenarios. For this reason, the team decided to develop code validators for programming languages studied in a University course dealing with web programming, which would allow to implement a tailored blended learning project for that course, supporting this way the implementation of the European Higher Education Area (EHEA) (EHEA, 2010) as it is understood by the Bologna declaration (EHEA, 1999).

Besides the enthusiasm of the team to implement a high quality and efficient learning project as promoted by the European Union in the “Education and Training 2020” framework, and that could contribute to the construction of the European Higher Education Area, an important starting point for the present project is the work developed by the World Wide Web Consortium (W3C) (W3C, 2011a) in the field of code validation, and more specifically, the code validators for (Extensible) Hypertext Markup Language ((X)HTML) (W3C, 2011b) and Cascading Style Sheets (CSS) (W3C, 2011c) that have been satisfactorily used by the students to check their own codes.

At this point, the idea of developing code validators for other programming languages arises. A search in relevant literature revealed that there were no equivalent validation services to those provided by the World Wide Web Consortium for (X)HTML and CSS, for
other programming languages such as JavaScript or PHP, that together with (X)HTML and CSS, are studied by students in web programming courses. It is true, however, that engines or interpreters are available for both JavaScript (Google, 2010) and PHP (PHP, 2011), but it is also true that it is impossible to make a pedagogic use of these applications as they are. For this reason, the team decides to develop code validators for JavaScript and PHP that could be used for pedagogic purposes, and to integrate them in the virtual learning platform Moodle (Moodle, 2011) currently used by students, so that they perceive the code validators as tools adequately integrated in their usual virtual learning environment.

After verifying that there were no code validators for JavaScript and PHP integrated in the virtual learning platform Moodle that could be used for pedagogic purposes, the team decided to develop such applications. So, the main objective was to develop code validators for JavaScript and PHP integrated in the virtual learning platform Moodle of which an adequate pedagogic use in the framework of a blended learning project could be done.

An important assumed hypothesis to be verified was that the use of such tools would make the learning project more attractive and interesting for students. Moreover, it was expected that the students perceived as positive the fact that the JavaScript and PHP code validators, unlike those offered for (X)HTML and CSS by the World Wide Web Consortium, were integrated in their usual virtual learning environment.

As the number of students that regularly attend the course involved in the experience is low, around 20 per semester, and as most of the work is done in small groups at the laboratory, it was decided to base the analysis in non-quantitative methods, but qualitative procedures instead, i.e. to observe the students’ opinion, both the opinions expressed verbally as well as those expressed through the different discussion forums created for this purpose.

2. METHODOLOGY

2.1 Context

The participants in the present work are a group of teachers of the department of Signal Theory and Communications, and Telematics Engineering of the University of Valladolid, that develop their work in the Telecommunication Engineering Technical School of that University. The course for which the applications have been developed - named Aplicaciones Telemáticas Multimedia - is a course focused on web programming that is part of two engineering study programmes offered by that University. Although the course
Aplicaciones Telemáticas Multimedia will not be taught during the next academic year 2011-2012 or later, it is the seed of a set of courses that will be part of four new engineering study programmes offered by the University of Valladolid, already adapted to the Bologna declaration guidelines. The present project has been developed at the Telecommunication Engineering Technical School of the University of Valladolid.

The present work is twofold, on one side, it is a software engineering project that has as result, a software product, on the other side it is also an ICT-based educational project. More specifically, the result will be a set of modules integrated in the virtual learning platform Moodle, that allow engineering students that start to develop web applications, to train themselves in order to control their advance in the context of a self-regulated blended learning process.

The student will enter a source code that will be automatically checked, taking into account different semantic and syntactic aspects of the corresponding programming language, and will be provided with a feedback that includes a list of errors that the source code contains or else a congratulation message in case that the source code submitted is completely correct. Key terms (names of functions…) will be highlighted, and the student will obtain information about each of them (function syntax …). Moreover, beside the diagnosis of the source code, and the online help about key terms, whenever a spelling mistake is detected, the most likely alternatives will be presented and the student will be able to select any of the suggestions to automatically replace the wrong term with the suggested term selected.

In addition, whenever a wrong code is checked, the student will be asked to select the error he think he committed from a list proposed by the teacher that should include the errors he perceives that are more often committed by his students. A record of the errors committed by each student is stored which allows to offer the users error statistics graphically represented. More specifically, each student can access the graphical representation of the statistics of his/her own errors while the teacher can access the graphical representation of the statistics of the errors committed by a particular student or by the whole group of students enrolled in a course. This errors management will provide teachers with valuable information as they can reinforce the explanation of the aspects of the programming language in which the students have committed more errors.
The modules developed rely on JavaScript and PHP engines to outsource the checking of the source codes submitted. However, additional checks to those done by the engines have also been implemented.

The Functional Requirements (FR) of the system developed can be summarized as follows:

- **Purpose.** The system will be able to check source codes that are created by students initiating themselves in the development of web applications. The system will be also able to process the data generated by the use that the students made of it.

- **Users management.** The system will allow to add new users in order to gather information regarding the errors committed by them.

- **Error checking.** The system will report the errors found during the checking of the source codes submitted. The checking of errors will be outsourced to an engine of the programming language in which the source code is submitted.

- **Data management.** The system will collect the data grouped by type of error in order to allow its graphical representation, both at user level and at course level. The system will also allow teachers to delete the data relative to any certain user when it is necessary.

- **Graphical representation of data.** The system will offer a graphical representation of the type of errors, in percentage, committed by a particular student or by the whole group of students in a course. A description of the different types of charts used to present the error statistics will be also provided as a help for the users.

- **Help system.** The system will provide information about the key terms that are found in the source codes submitted. Moreover, when spelling mistakes are found in the key terms of a source code submitted, the system will suggest the most likely alternatives, leaving the user the possibility to automatically replace the wrong term with any of the suggested alternatives.

- **Errors management.** The system will allow to create, to modify or to delete an error type to be taken into account in the error statistics and in its graphical representation, as well as to modify the information provided about each type of error. The system will also report any type of incident occurred during any of these processes.
- Submission of source codes to be checked. The system will allow to import a source code from an external file or else to insert the source code directly in a devoted text editor.

- Categorised access according to the type of user. The teachers will have all the privileges inside the system. The students, however, will only have access to the checking and help functionalities and also, to the charts generated with the errors committed by them. In order to use the system it will be previously necessary to access a specific course of the virtual learning platform Moodle and to identify him/herself as teacher or as student.

2.2 Description of the System

After accessing through the browser to a course available in the virtual learning platform Moodle that offers the application, the user can access to it by pressing its name. Immediately after, the application initial screen, as teacher (see Figure 1) or as student, is presented, which gives access to the different activities that can be undertaken.

![Validator PHP](image)

**Figure 1: Initial screen as teacher**
After accessing the system, a brief information is presented, whose aim is to allow the user a better understanding of the functionalities of the application.

If the user wants to check a source code, he can introduce it directly into the text editor integrated in the application, or even upload an external file (.js or .php) that contains the whole code. The application text editor (Editarea, 2010) offers typical options such as new blank document, text search and replace, go to a certain line, undo action or redo action and other more specific options such as syntax highlighting (see Figure 2).

![Application text editor](image)

**Figure 2:** Application text editor (Editarea, 2010), syntax highlighting

The result of checking a source code is presented over the text editor. Whenever the application finds an error in the code the user is asked to select the most likely type of error committed from a list defined by the teacher (see Figure 3) in order to update the error statistics.
A help system has been implemented to allow the user to check the syntax of key terms. First of all, when the mouse pointer passes over any of these terms, it changes from an arrow into an interrogation symbol and the term can be pressed in order to access to a description of the term (see Figure 4).

Figure 4: Description of a key term
The application also underlines all the key terms where spelling mistakes have been detected. When passing over one of these terms, the mouse pointer changes from an arrow into a hand and when pressing the term, a high number of alternatives suggested by the application are shown over the text editor (see Figure 5). If the user selects one of the suggested alternatives, the application replaces the original term with the alternative selected by the user.

Concerning to the graphical representation of data related to the errors committed by the students, the possibilities are different according to the type of user. Students only have the possibility to generate charts with their own data while teachers can also access the students’ charts representing the errors committed by all of the students who belong to a course. Both of them, students and teachers, can select the type of chart to be used to represent the statistics of the errors committed from the different types of charts offered by the application (see Figure 6, Figure 7, Figure 8 and Figure 9). In the case of the teachers, besides generating any chart that represents error statistics, they can modify the values of the characteristic parameters for every type of graph (see Figure 10).
Errores cometidos por Felipe Perez Dios

Figure 6: Pie chart

Errores cometidos por Felipe Perez Dios

Figure 7: Bar chart

Errores cometidos por Felipe Perez Dios

Figure 8: Piled up bar chart
The application has got a management area where the teacher can undertake different actions related with the management of the charts and of the data used to generate those. More specifically, the teacher can add, modify or delete an error type (see Figure 11) from the list of errors taken into account to generate a chart with error statistics. Also, the teacher can set the default values or modify the values of the parameters that are taken as a base to generate the different types of charts. Although the teacher has the option to modify the values of the parameters related to a certain type of chart each time a chart is shown, the student will view his statistics under the configuration established by the default parameters. The teacher can also delete all the stored data about a particular user.
Finally, regarding the errors management, some examples of the outputs provided by the application are presented (see Figure 12 and Figure 13).

**Figure 12:** Error detected: incorrectly declared variable (as for example $variable 1 = variable 2 ⇔ $variable 1 = $variable 2)

**Figure 13:** Error detected: omitted points (as for example $termino = $termino"ejemplo" ⇔ $termino = $termino."ejemplo")
3. RESULTS

As a software engineering project, the result of the present work is an application that meets all the requirements initially established. More specifically:

- It is designed as a module for the open source virtual learning platform Moodle and offers a friendly user interface.
- It is able to check source codes, as those typically elaborated by engineering students initiating themselves in the development of web applications.
- It provides a help system for the syntax of key terms.
- It checks the spelling of key terms and suggests the most likely alternatives.
- It collects and stores information about the use made of the system.
- It provides an independent access to the collected data from each user of the system.
- It offers the possibility to delete the stored data about one or more users.
- It allows to present all the stored information in different types of charts for which the values of different parameters can be adjusted.

The application has been tested with engineering students in the Aplicaciones Telemáticas Multimedia course focused on the development of web applications offered by the University of Valladolid in two engineering study programs. This testing in a real scenario was aimed to collect feedback data and comments in order to improve the application tailoring it to the needs of the target users and enhancing their experience with the application.

As a software product, feedback from students suggested a set of further developments to provide the application with an added value, that are the following:

Add multilingual support. Moodle works with language packages which will facilitate that translation of the application into different languages.

Support the checking of other programming languages further than the JavaScript client-side and the PHP server-side scripting languages.

Both of the above suggested improvements will allow to increase the number of potential users of the application.

Develop a system that allows to self complete key terms in the text editor. Even if the application was initially addressed to check a code correctness, it may be useful to incorporate the most common structure layouts used in the programming languages with which it is able to work.
To use new types of charts to represent the statistics of the errors committed by the users as this could contribute to a better understanding of the users’ needs. For example, an interesting option could be to compare the results obtained by the students of a same course in different academic years or by the students of different courses in the same academic year.

Finally, the most demanded improvement by the students that used the system was to integrate all the code validators in one, i.e., to count with a validation service integrated in Moodle where they could enter a code of any type, in our context (X)HTML, CSS, JavaScript or PHP, or a mixture of those as it usually happens, and that the corresponding engines were called to do the necessary validation in order to provide the adequate feedback.

In which regards to the pedagogic aspect of the experience, the observation of the interaction of students during the laboratory sessions and of the opinions expressed by them in the discussion forums revealed that:

Most of the students - 90 % - perceived the possibility of using code validators as positive, both the ones offered by the Web Consortium and those developed in this work.

Most of the students - 85 % - thought that it was better to have the code validators integrated into the virtual learning platform that supports the course, i.e., Moodle, than to have to access them externally.

However, most of the students - 95 % - still preferred feedback from teachers. Their opinion was that the feedback from the system was valuable in case the teacher was not available, for example, when they were working at home or at the laboratory but the teacher was busy attending other students. However, if the teacher was available, most of the students preferred to talk to him than to obtain feedback from the system.

4. CONCLUSIONS

Taking into consideration the results of the project, the main conclusions of the present work focusing on the pedagogic aspect, are, so far, the following:

- The work of teachers is very valuable and can difficulty be replaced by any ICT-based tool.
- However, ICT-based tools can enhance the experience of both students and teachers during a blended learning process.
- To support a course through a single virtual learning environment is preferable than to have to access different stand alone tools, both for teachers and students.
- To count with tailored educational tools, such as is the case of code validators for a web programming course, is always an asset.
- The tools used in an e-learning project must be pedagogic and student-oriented.

5. REFERENCES


