Robles-Gómez, A., Ros, S., Hernández, R., Tobarra L., Caminero, A. C., & Agudo, J. M. (2015). User Acceptance of a Proposed Self-Evaluation and Continuous Assessment System. *Educational Technology & Society, 18* (2), 97–109.

User Acceptance of a Proposed Self-Evaluation and Continuous Assessment System

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ABSTRACT

The WWW nowadays enables faculty to develop new Internet-based applications that can be used to enhance classroom instruction. There is a clear evolution towards the implementation of new service-oriented learning/teaching systems, which can be considered as the latest generation of Internet-based platforms. This work first describes a service-oriented system in order to follow the students' progress and automatically assess their practical activities, not theoretical knowledge. The service oriented paradigm allows us to implement a more advanced system for the self-evaluation and continuous assessment of the students' progress in the field of Information Technology, where activities measure practical daily-work skills. Second, the Technology Acceptance Model (TAM) is used to analyze the acceptance of our proposal. In the results obtained, the participants found the system significantly easier to use, and it proved useful for their purposes. It is also concluded that participants (students and faculty) feel confident with the system.

Keywords

Distance education, Architectures for educational technology systems, Self-evaluation and continuous assessment, Technology Acceptance Model (TAM), Improving on-line teaching

Introduction

New issues related to the learning process in the field of higher education, especially on-line or distance evaluation, are currently a hot topic of research, and it is of a great interest due to the growing use of Internet (Ryan et al., 2000; O'Reilly, 2007; Dagger et al., 2007; Muñoz-Organero et al., 2010). Basically, the evaluation process consists of determining whether the educational objectives are actually achieved. This fact includes not only the student, but all the elements involved in an educational program (given educational resources, faculty, etc.). Faculty must be able to adapt the learning process to students, strengthening or expanding it as appropriate within the context of the European Higher Education Area (EHEA). In addition to this, if we focus on a distance methodology (Carswell et al., 2000; Morgan et al., 2002; Schrum et al., 2007), the evaluation process becomes an even more important and indispensable instrument within the learning process. By using the available evaluation elements, faculty determines the chosen learning outcomes and, at the same time, the subject content can be adapted dynamically to students. Since interaction between faculty and students within a distance methodology increases during the evaluation process, performing this in an efficient and correct way is essential in order to achieve the previously proposed objectives, as already stated in (Robles-Gómez et al., 2011; Agudo et al., 2011).

This work describes a solution, based on the service-oriented paradigm, to follow the progress of students and, automatically, assess the students' practical activities. In order to analyze its acceptance, the Technology Acceptance Model (TAM) is adapted for our purposes, since there is a lack of references related to self-evaluation and continuous evaluation service oriented systems. This model is based on the perception of utility and ease of use as key factors when deciding on the use of Information Technologies (ITs). In this sense, TAM questionnaire results for each item will be presented for both students and faculty members.

In order to center this work, the system will only use activities related to the configuration of network services. Its scope is much broader, since this system has been designed and implemented as a modular system, which is independent of the design and implementation of specific activities. In this regard, we focus on the "*Network Services Management in Operating Systems*" (NetServicesOS) course belonging to the "*Communications, Networks, and Content Management*" post-graduate program at Spanish University for Distance Education (in Spanish, Universidad Nacional de Educación a Distancia). In our traditional evaluation approach, once a student finished an activity, he/she proceeded to write a solution document detailing how he/she had solved the requested work, and uploaded it in the virtual platform for its evaluation. After each deadline, faculty could assess the students' activity from this document, although it was difficult to check the correctness of the activity, since the activities of the subject are very practical which involve starting some network services and, also, creating and modifying a set configuration files, among others (Robles-Gómez et al., 2011; Agudo et al., 2011).

Thanks to the use of the service-based system, faculty can track the progress of a large number of students and adapt dynamically the learning/teaching process. In particular, the system is able to automatically assess the practical activities of the subject, detect possible failures within the network services and configuration files, and help faculty to understand the main weaknesses of students during the process of learning from the evaluation reports that the system generates. These features are not possible in traditional Learning Management Systems (LMSs), since they only focus on multiple choice, questions, short answer questions, or similar, but not practical activities, as our case is. From all this information, faculty will be able to dynamically adapt the content or evaluation resources to the students' skills if necessary. Students can also receive lively feedback on their activities – which was totally impossible with our traditional evaluation system based on explanation reports for each activity. More details are given in Robles-Gómez et al. (2011) and, afterwards, in Agudo et al. (2011).

Among the principal features of this work, we can find that (1) this paper adapts TAM for educational purposes (2) to study a self-developed automatic evaluation tool from the point of view of both student and faculty participants, (3) which is used in the largest distance University in Spain (over 220,000 students and 2,000 lecturers), (4) in a post-degree subject related to the Computer Science discipline, where practical activities are employed to assess students' skills, even more, in post-graduate programs. These characteristics jointly make this work different from the literature, which presents results of great interest for researchers and learning practitioners.

This paper is organized as follows. Next section describes the most relevant related approaches found in the literature. After that, this work presents the self-evaluation and continuous assessment service-oriented system. In addition to this, the methodology used to study the acceptance of the system in the field of distance higher education is described and, also, the results obtained from this study are discussed. Finally, the paper outlines our conclusions and possible future work.

Background

Current e-learning platforms mainly belong to the second generation of platforms (Moodle, Sakai, dotLRN…) which can be defined as monolithic (Muñoz-Organero et al., 2010). They provide centralized learning, based on contents distributed by lecturers. These platforms offer evaluation methods focused on theoretical contents, where students can immediately verify their knowledge by multiple-choice tests or exercises of concept associations (Douce et al., 2005). Furthermore, the use of these kinds of technologies provide us with a new set of functionalities, not available in traditional educational environments, such as fast interaction, anywhere and anytime access and usage, and valuable discussions that help the student to improve his/her learning process. In spite of these new capabilities, it is quite common to use traditional evaluation techniques, such as essays or exams, since the costs for the implementation of continuous assessment can be very elevated. However, when preparing educational programs, the execution of a continuous assessment within the students' evaluation process is really important in order to follow their progress in an efficient way.

According to the implementation of new service-oriented learning/teaching systems, also called third generation platforms (Dagger et al., 2007; Muñoz-Organero et al., 2010), there is a clear evolution towards the usage of personal e-learning environments. State-of-the-art e-learning developments, such as (Wilson et al., 2006; Dabbagh et al., 2012) make use of Personal Learning Environments (PLEs) that are based on services. Service-oriented applications can be considered as the latest generation of Internet-based platforms. They are understood as a set of Web-based services and users are considered as the principal actors of the system. These properties allow faculty to implement more advanced systems, in our case, for the management of the self-evaluation of practical activities and the continuous assessment of the students' progress. Currently, there are not fully-functional implementations related to these topics jointly, due to the complexity of correction by a computer without having an objective response solution. Faculty chooses non-scalable solutions, often based on proprietary developments to meet part of these needs (Gutiérrez et al., 2010; Lorenzo et al., 2011).

Several efforts have been made towards the automatic evaluation of contents. Guerrero, Bataller, Soria, & Magdalena (2007) presented the BioLab tool which is used for the learning of biosignal processing in the biomedical engineering module of the Electronic Engineering degree at the University of Valencia (Spain). This tool allows results to be obtained interactively during theory lessons and provides support in laboratory sessions. Additionally, Barry (2012) presented a video-recording system for oral presentations of students' groups, for later viewing and self-assessment by members of the student group. Nevertheless, the main drawback of these two proposals is that, although they provide students with interactive help during some steps of the course, they do not perform an automatic evaluation of the students' activities. In order to minimize this problem, a specific system for assisting evaluation using test cases was proposed by Lorenzo, Vélez, & Peñas (2011). The mains drawbacks of this proposal are that the system only provides a partial-automatic evaluation, based on a set of test cases predefined, it does not implement a continuous assessment process, and authors do not evaluate the students and/or faculty's acceptance of the system.

On the other hand, Robles-Gómez et al. (2011) outlined the teaching of a course related to the management of network services, which has been adapted to the context of the new EHEA. A first prototype was also defined for the automatic assessment of the students' activities. In addition to this, Agudo et al. (2011) implemented a particular version, which allow faculty to manage the continuous evaluation of the students' progress in Linux activities to be used in the subject. For this reason, it has been thoroughly evaluated in this work, by adapting the Technology Acceptance Model (TAM) to our purposes.

Description of the system

Service-oriented applications are considered as the latest generation of Internet-based platforms. Using the system, students will be able to perform a self-evaluation of their activities and, additionally, the system will be able to automatically correct a student's practical activities by modifying their configuration files or, even more, configure it completely, with a penalty in the mark for the activity, as proposed by Robles-Gómez et al. (2011). The system has several main benefits for the members of the learning community, specially, within the field of a distance higher education. First, it minimizes the response time in correcting students' practical activities, allowing the continuous evaluation process to be performed smoothly. Furthermore, it provides a more detailed monitoring of the students' progress, thereby reducing the time spent on the assessments themselves. The importance of these benefits is really significant, since the number of students enrolled in a course with a distance methodology can become very high (Robles-Gómez et al., 2011). Thus, faculty can focus on other tasks, such as dynamic adaptation of new activities to students' necessities or expanding the existing ones, which in turn improves the learning process more than devoting their time to correcting the students' activities.

The system is made up of two different: the faculty's view and the students' view parts (Robles-Gómez et al., 2011; Agudo et al., 2011). From the faculty's view, faculty can perform subject management tasks such as selecting the activities for the subject, creating different groups with activities adapted to the students' level, checking students' progress by means of reports, etc. The Web application, shown in Figure 1, is accessible by faculty through any Internet browser. Note that the system allows faculty to split up the subject's students by levels or types of activities. In addition, the system provides statistics about the student's run status and run time. Finally, a list of recent reports is stored for each of them, which can be checked by faculty at will. From the students' view, the system can automatically configure and/or evaluate a particular activity. For this purpose, the system will download a handler via Internet, and run it inside the students' infrastructure by using virtual machines, in order to analyze and/or configure the most important configuration elements and generate an evaluation/configuration report. So, students find out which parts of a particular activity are wrong and, additionally, the system can help students when they are not able to do a part of the activity. All this information will be automatically updated on the server side so that it can be used by faculty to improve the learning process.

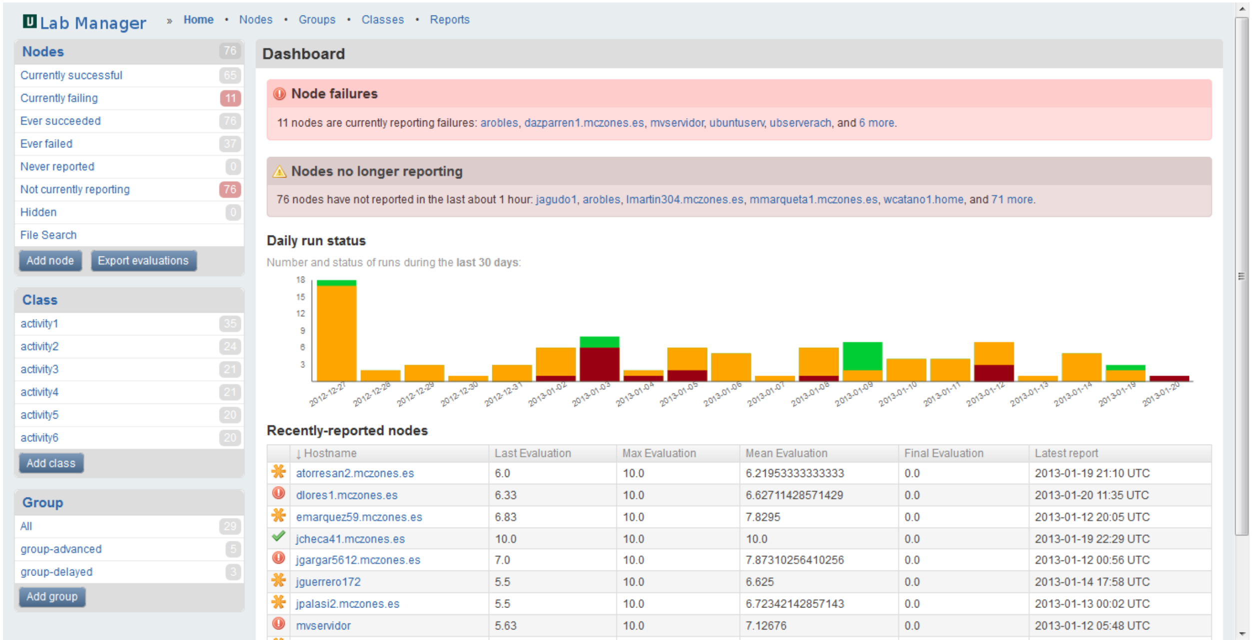

Figure 1. Web-based interface (Faculty view) (Agudo et al., 2011)

Architecture of the system

When designing and implementing our service-oriented system, a range of technologies and components were selected, all of them having open source licenses. The system represented in Figure 1 was built using Puppet, which provides most of the relevant components for the automatic evaluation system, and a Ruby on Rails application was developed to meet the needs for the graphical tool. However, we are currently replacing both technologies by only the open-source Flask framework, which is based on Python, in order to have all components of the system, including the self-evaluation pieces and the Web application, fully integrated with the same technology. This will allow us to increase the flexibility of the system, when deploying new services for the system. For both cases, the system follows the Model-View-Control (MVC) paradigm, an architectural design pattern widely used in Internet. The communication between the main elements in the implemented architecture is driven by REpresentational State Transfer (REST) Web-based service interfaces. REST is an architectural software technique for hypermedia distributed systems such as the World Wide Web (WWW). Since it uses HyperText Transfer Protocol (HTTP) as a binding communication protocol, REST services are stateless. This means that each HTTP message contains all the information needed to process a request.

In addition to the REST service properties, in each client/server service-oriented connection, Agudo et al. (2011) proposed a safe SSL channel for encrypting data by means of digital certificates for both endpoints. When starting the request phase, a pair of public/private keys is generated and the certificates needed are signed, automatically or under the supervision of the administrator, by the server as the certificate authority. Security issues will be increased by using the native functionalities provided by the Flask framework. Thus, client impersonation is avoided and there is a suitable security level for remote client configuration. In order to improve the performance and the scalability of our service-oriented evaluation system, given the high number of simultaneous users that this tool must support, Apache HTTP Server and Passenger were chosen for the deployment of our solution. Passenger is a module that mainly helps Apache to improve the performance, scalability, and security issues when deploying the system. Again, when the system is fully-migrated to the Flask technology, our proposed system will achieve the same levels of scalability by simplifying the number of technologies to be employed and, also, by increasing its maintenance.

The implementation of the self-evaluation and continuous assessment system follows a service-oriented paradigm. The concrete architecture of the system is shown in Figure 2, including the interaction among its main elements, which are Web Client, Lab Manager, and Web Server. The Web Client element is executed by the student, at the remote location that he/she uses for the performance of his/her practical activities. It is in charge of connecting with the Web Server element through the Internet, evaluating the desired configuration (depending on the configured activities at the server) and showing the differences compared with the current configuration. Finally, it must also create an evaluation report with the results of the evaluation and store it in a results database. In addition, the student could run the proposed system so that it automatically configures the student's local infrastructure. This last operation can only take place with the faculty's permission, so that the learning and evaluation processes are not jeopardized.

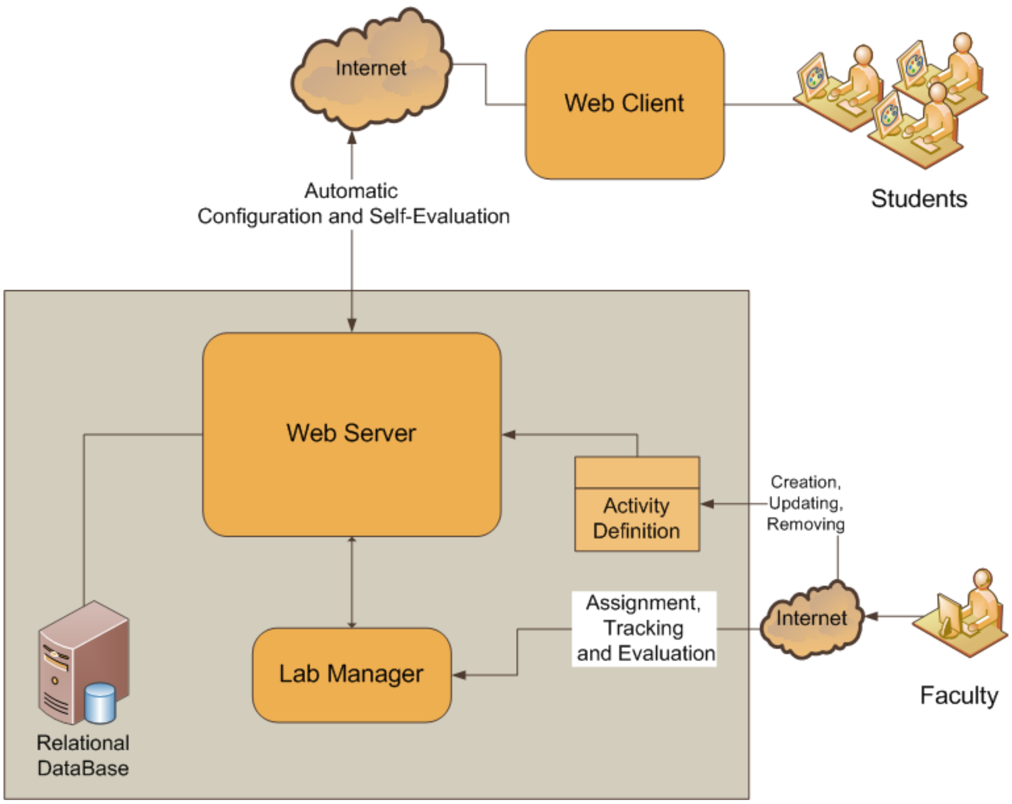

Figure 2. Architecture of the system (Agudo et al., 2011)

On the other hand, as observed in Figure 2, the Lab Manager allows faculty to assign activities to the students or track their progress in an easy and simple way. It can also provide, on request, the activities associated to students and confirm/modify the grades calculated by the system. It is accessible by faculty through any Internet browser. As a previous step, faculty is in charge of defining a set of practical or real-work activities to be performed by students, in form of manifests. A manifest is the definition of the requirements that must be fulfilled by each activity. Under these considerations, an activity is a group of one or more manifests, such as the configuration of a DNS server, for example, and they are associated to a particular service that must be evaluated. As for the Web Server, it is used to check the students' configurations. It first establishes the communication between Web Clients and Web Server. Furthermore, the Web Server obtains the activities associated to each student. It also registers the execution of the activities by students. In addition, the Web Server is ready to support more in-depth analysis, so that more knowledge can be inferred from the manifests in order to improve the evaluation process. When the whole system will be migrated to the Flask framework, will be much simpler to analyze all generated information, in order to extract conclusions to be dynamically adapted to the system. Finally, a relational database server, as MySQL is, has been chosen for storing the generated reports, as well as a data model of users, groups, variables and evaluations.

Methods

We have conducted a study in order to collect information about usefulness and ease of use of our proposed system, and how comfortable our students are when using it.

Participants

The study conducted was composed of two parts: the first one was focused on students and the second one on lecturers. For the first part of the study, the sample population consisted of 52 students enrolled in the NetServicesOS course belonging to a “Communications, Networks, and Content Management” post-graduate program in the Faculty of Computer Science at our University. In addition, 12 faculty participants were chosen from the Faculty of Computer Science at our University. Neither faculty nor students had previous experience with the system. The idea of working with faculty from computer-related disciplines was to control the variable of computer literacy as a factor in the study, allowing us to focus on their intention to use the system for their computer science subjects, and the trust provided by our proposed system. It has been demonstrated in other works that familiarity with a topic can affect the use of a tool (Belkin et al., 2003).

The profile of the students fits with the standard average of computer science postgraduates. Most of them are Spanish students between 24 and 35 years old with most men (70%) versus women (30%). In this study, we also had two South-American female students. As for faculty, all of them are from Spain between 30 and 50 years old with most men (75%) versus women (25%). For both parts of the study, a qualitative analysis was performed. In this type of analysis, the size of the sample is not a problem since opinions tend to repeat themselves, after a low number of questionnaires (Johnson et al., 2007; De La Fuente-Valentín et al., 2011).

Procedure

The questionnaire was an adaptation of the Technology Acceptance Model (TAM) developed by Davis (1993) to explain how users come to accept and use a technology. This model is based on the Theory of Reasoned Action (TRA) introduced by Fishbein & Ajzen (1975), and it is thought to predict and explain the users’ acceptance of a given technological element (Morris et al., 1997). This model, widely used in different studies related to technology acceptance, is based on the perception of utility and ease of use as key factors when deciding on the use of Information Technologies (IT) in terms of usefulness and ease of use. It has been suggested that the TAM is a cost-effective tool for predicting user acceptance of systems. None of them is related to self-evaluation and continuous evaluation service-oriented systems.

The related works which apply TAM to infer learners’ willingness to accept e-learning systems have also been proposed in recent years (Liaw et al., 2003; Yi et al., 2003; Ong et al., 2004; Pan et al., 2005; Pituch et al., 2006; Ngai et al., 2007; Liaw, 2007; Capra et al., 2007; Raaij et al., 2008; Liu et al., 2010; Curlango-Rosas et al., 2011; Persico et al., 2014). Similarly to these works, TAM will be used to analyze the acceptance to using our service-oriented system, in terms of ease of use, usefulness, and trust, for both student and faculty participants.

Table 1. Adapted TAM questionnaire statements used to measure students’ perceptions in terms of ease of use and usefulness, and additional statements related to students’ trust

	Student’s statements (SS)
SS1	Learning to use the SYSTEM to configure and check my activities is easy for me.
SS2	I would find it easy to get the SYSTEM to do what I want it.
SS3	My interaction with the SYSTEM is clear and understandable.
SS4	I find the SYSTEM easy to use to configure and check my activities.
SS5	I find the SYSTEM flexible to interact with.
SS6	It is easy for me to become skillful at using the SYSTEM to configure and check my activities.
SS7	Using the SYSTEM to configure and check my activities can enable me to accomplish my work more quickly.
SS8	Using the SYSTEM to configure and check my activities can improve my learning.
SS9	Using the SYSTEM to configure and check my activities in my job can improve my productivity.
SS10	Using the SYSTEM to configure and check my activities can enhance my effectiveness.
SS11	Using the SYSTEM to configure and check my activities can make it easier to do my work.
SS12	I find the SYSTEM useful to perform my activities.
SS13	My trust in the SYSTEM is enough when configuring and checking my activities.
SS14	My trust in the SYSTEM allows me to improve my learning.
SS15	The trust that the SYSTEM provides me with is satisfactory.

Therefore, participants were asked to express how useful and easy to use they considered the system in order to automatically evaluate their progress and, where necessary, configure some parts of their practical assignments. Table 1 shows the adapted TAM statements from the point of view of students. For this study, the word SYSTEM was shown to participants. Participants were presented with the statements in Table 1 in random order and asked to indicate how they felt about each statement. Statements 1-6 (SS1-SS6) measure participants' perceptions of the system's ease of use. Statements 7-12 (SS7-S12) measure participants' perceptions of the system's usefulness. Similarly, additional statements (SS13-SS15) were asked to measure participants' perceptions of the system's trust. The items used in the survey have been adapted from the previous works (Davis, 1993; Curlango-Rosas et al., 2011). Each item is a five-point Likert-type scale ranging from (1) "Strongly Disagree" to (5) "Strongly Agree" (Davis, 1993; Capra et al., 2007). A similar procedure was followed for the second part of the study, in which faculty participants were asked to follow the status of the students' activities, examine the functionality of the system, and proceed to check the correction of the activities implemented by students throughout the duration of the NetServicesOS course. These statements are shown in Table 2.

Table 2. Adapted TAM questionnaire statements used to measure faculty's perceptions in terms of ease of use and usefulness, and additional statements related to faculty's trust

Faculty's statements (FS)	
FS1	Learning to use the SYSTEM to manage students' progress is easy for me.
FS2	I would find it easy to get the SYSTEM to do what I want it to do.
FS3	My interaction with the SYSTEM is clear and understandable.
FS4	I find the SYSTEM easy to use to manage students' progress.
FS5	I find the SYSTEM flexible to interact with.
FS6	It is easy for me to analyze students' skillfulness at using the SYSTEM.
FS7	Using the SYSTEM to manage a student's progress can enable me to accomplish my job more quickly.
FS8	Using the SYSTEM to manage a student's progress can improve my teaching.
FS9	Using the SYSTEM to manage a student's progress can improve my productivity.
FS10	Using the SYSTEM to manage a student's progress can enhance my effectiveness.
FS11	Using the SYSTEM to manage a student's progress can make my job easier to do.
FS12	I find the SYSTEM useful to perform my job.
FS13	My trust in the SYSTEM is enough when tracking my students' progress.
FS14	My trust in the SYSTEM allows me to use it during the evaluation process.
FS15	The trust that the SYSTEM provides me with is satisfactory.

Results

In this section, we present results from both parts of our study. The TAM questionnaire results for each item are presented for all participants (students and faculty). In particular, we show median and mean values, and standard deviation for all collected data. After that, the global user acceptance scores are summarized for each construct (ease of use, usefulness, and trust) in order to compare student and faculty results.

Student and faculty TAM questionnaire results

We obtained the responses to all statements in the TAM section of the questionnaires. Table 3 shows the median and mean values, as well as standard deviation of the responses for the statements regarding participants' perceptions (students and faculty) of our proposed system's ease of use (SS1-SS6 and FS1-FS6), usefulness (SS7-SS12 and FS7-FS12), and trust (SS13-SS15 and FS13-FS15). All values shown range from (1) "*Strongly Disagree*" to (5) "*Strongly Agree*."

First, we explain the data collected from the student survey, which corresponds to the mean values of the left side of Table 3. It can be observed that learning to use the proposed system when configuring and checking activities is really easy for the students enrolled in the subject (SS1 – 4.07). For this statement, its median value corresponds to 4, which can be considered as "Really Agree." For the next statement, students agree it is easy to get the system to do what they want (SS2 – 3.66), and they do not agree or disagree that their interaction with the system is clear and understandable (SS3 – 2.98). In these cases, median values correspond to 3.5 and 3, respectively, which can be considered as “Agree” and “Neither Agree nor Disagree” for each of them. Both of them may be the weakest values in the survey, since their interaction with the system was rudimentary, so it is not intuitive at first. In contrast to this, and a really positive point, students find the system easy to use in order to configure and check their activities, and they also find it flexible to interact with (SS4 – 4.11 / SS5 – 3.75, respectively). In general, it is easy for students to become skillful at using the system to configure and check their activities (SS4 – 3.74).

Table 3. TAM questionnaire results for perceived ease of use, usefulness, and trust: median (mean) and standard deviation. Results for students (on the left side) and faculty (on the right side)

Construct	Students' statement	Median (mean)	Stand. dev.	Faculty's statement	Median (mean)	Stand. dev.
Ease of use	SS1	4 (4.07)	0.90	FS1	4.5 (4.47)	0.67
	SS2	3.5 (3.66)	1.05	FS2	4 (4.11)	0.75
	SS3	3 (2.98)	1.23	FS3	3.5 (3.73)	0.95
	SS4	4 (4.11)	0.88	FS4	4.5 (4.34)	0.80
	SS5	4 (3.75)	1.12	FS5	4.0 (3.91)	1.10
	SS6	3.5 (3.74)	0.93	FS6	4.5 (4.47)	0.67
Usefulness	SS7	4 (3.83)	1.1	FS7	4 (4.00)	0.83
	SS8	4.5 (4.66)	0.53	FS8	4.5 (4.56)	0.65
	SS9	3.5 (3.73)	1.03	FS9	4.5 (4.40)	0.67
	SS10	4.5 (4.43)	0.57	FS10	4.5 (4.47)	0.67
	SS11	4.5 (4.47)	0.64	FS11	4.5 (4.47)	0.67
	SS12	5 (4.77)	0.40	FS12	4.5 (4.71)	0.45
Trust	SS13	4 (3.79)	1.05	FS13	4 (3.91)	0.66
	SS14	4.5 (4.25)	0.62	FS14	4 (3.93)	0.79
	SS15	4.5 (4.43)	0.64	FS15	4 (4.24)	0.65

According to the usefulness of the system for the configuration and checking the correctness of activities, students really agree that the system enables them to accomplish their work more quickly, since the median value obtained is 4 (SS7 – 3.83). In addition, they fully agree that the system is really able to improve their learning and suitable when configuring and checking their activities (SS8 – 4.66). Also, students agree the system improves their productivity (SS9 – 3.73). Additionally, students fully agree that the system enhances their effectiveness and makes it easier to do their work (SS10 – 4.43 / SS11 – 4.47, respectively). In general, it can be observed that students agree about the usefulness of the system in order to perform their activities (SS12 – 4.77). Note that the median value of this last statement is 5, which corresponds to “Strongly Agree.” As for students’ trust in the system, they find the system totally trustworthy (SS15 – 4.43), since its median value is 4.5. More in detail, many students agree that the trust provided by the system is enough when checking their activities (SS13 – 3.79). They fully agree that their trust in the system allows them to improve their learning (SS14 – 4.25).

We now describe the data collected from the faculty survey, which corresponds to the mean values of the right side of Table 3. It can first be observed that faculty participants fully agree that learning to use the proposed system in order to manage students’ progress is easy (FS1 – 4.45), since its median value is 4.5. Likewise, faculty participants really agree that it is easy to get the system to do what they want (FS2 – 4.11). In addition, most of them agree that their interaction with the system is clear and understandable (FS3 – 3.73). The reason could be that they interact with the system by means of an advanced graphical interface. Furthermore, they find the system really easy to use in order to manage students’ progress (FS4 – 4.34), and they find it flexible to interact with (FS5 – 3.91). This last value is slightly lower, since faculty participants are more conscious this type of systems could be vulnerable. This is not our case thanks to the encrypted communication included within the system. Faculty participants agree the system makes it easy to analyze students’ skillfulness (FS6 – 4.47), since its median value is 4.5.

According to the usefulness of the system for managing students’ progress, faculty participants really agree that the system enables them to accomplish their job more quickly (FS7 – 4.00). They fully agree that the system is able to improve their teaching and productivity (FS8 – 4.56 / FS9 – 4.40, respectively), since their median values are 4.5. Also, most of the faculty participants strongly agree that the system enhances their effectiveness and, similarly, on the fact that the system makes it easier to do their job (FS10 and FS11 – 4.47). In general, it can be observed that faculty participants find the system suitable when performing their job (FS12 – 4.71).

As for faculty's trust in the system, they find the system really trustworthy (FS15 – 4.24), since its median value is 4. More in detail, faculty participants really agree that the trust provided by the system is enough when tracking students' progress (FS13 – 3.91). They also agree that their trust in the system allows them to use it during the evaluation process (FS14 – 3.93). Note that the standard deviation of all presented values is quite low. This fact implies that many participants have similar opinions with regarding most of the statements. To finish this section, it can be concluded from the previous explanations that the proposed system is easy to use, although students have a weaker opinion than faculty. Both of them really agree about the usefulness of the system, and their trust is very high.

User perceptions using percentages

In this section, results for the participants' perceptions are detailed using percentage values. Table 4 presents these results for the students' perceptions, analyzing their ease of use, usefulness, and trust. In this case, percentages are shown for all statements with respect to each possible response. It can be observed that learning to use the proposed system when configuring and checking activities is really easy for students enrolled in the subject, since 92% of them agree on this (those who answered 4 or 5 to SS1). Also, 80% of students agree it is easy to get the system to do what they want (those who answered 4 or 5 to SS2). In contrast, only 58% of students think their interaction with the system is clear and understandable (see results from SS3). The reason could be that their interaction with the system was still rudimentary, but it is most important that they do find the system easy to use to configure and check their activities and flexible to interact with (see results from answers 4 or 5 to SS4 and SS5, respectively). Note that, in general, it is easy for students to become skillful at using the system to configure and check their activities, since 84% of them agree on this.

Table 4. Results for students' perceptions in terms of ease of use, usefulness, and trust (%)

Construct	Students' statements (SS)	1	2	3	4	5
Ease of use	SS1	4 %	0 %	4 %	19 %	73 %
	SS2	4 %	4 %	12 %	30 %	50 %
	SS3	4 %	23 %	15 %	31 %	27 %
	SS4	0 %	4 %	15 %	23 %	58 %
	SS5	4 %	4 %	15 %	8 %	69 %
	SS6	4 %	0 %	12 %	42 %	42 %
Usefulness	SS7	0 %	11 %	15 %	12 %	62 %
	SS8	0 %	0 %	4 %	19 %	77 %
	SS9	4 %	4 %	8 %	30 %	54 %
	SS10	0 %	0 %	4 %	30 %	66 %
	SS11	0 %	0 %	8 %	27 %	65 %
	SS12	0 %	0 %	0 %	20 %	80 %
Trust	SS13	4 %	4 %	8 %	23 %	61 %
	SS14	0 %	0 %	8 %	50 %	42 %
	SS15	0 %	0 %	8 %	30 %	62 %

According to the usefulness of the system for the configuration and checking the correctness of activities, 74% of students think it enables them to accomplish their work more quickly (those who answered 4 or 5 to SS7). In addition they believe the system is really able to improve their learning and productivity when configuring and checking their activities, since 96% and 84% of students agree on this, respectively (see results from SS8 and SS9). Furthermore, students may well think that the system enhances their effectiveness because of the fact 96% of them agree on this and, similarly, 92% of them agree on the fact that the system makes it easier to do their work (those who answered 4 or 5 to SS10 and SS11). It can be observed that 100% of students find the system suitable when performing their activities (see results obtained from SS12). As for students' trust in the system, in general, the trust it provides is satisfactory, since 92% of students agree on this (see results from SS15). More in detail, 84% of students' trust is enough when checking their activities (those who answered 4 or 5 to SS13). Also, 92% of them believe that their trust in the system allows them to improve their learning (see results from SS14).

As for faculty, Table 5 presents the results obtained for the faculty's perceptions using percentage values, in order to analyze ease of use, usefulness, and trust. The conclusions obtained from these results, not detailed due to the lack of space, are more or less similar to the students' perceptions.

Table 5. Results for faculty' perceptions in terms of ease of use, usefulness, and trust (%)

Construct	Faculty's statements (FS)	1	2	3	4	5
Ease of Use	FS1	0 %	0 %	8 %	25 %	67 %
	FS2	0 %	0 %	16 %	42 %	42 %
	FS3	0 %	8 %	17 %	42 %	33 %
	FS4	0 %	0 %	17 %	17 %	66 %
	FS5	0 %	8 %	17 %	17 %	58 %
	FS6	0 %	0 %	8 %	25 %	67 %
Usefulness	FS7	0 %	0 %	25 %	33 %	42 %
	FS8	0 %	0 %	8 %	17 %	75 %
	FS9	0 %	0 %	8 %	33 %	59 %
	FS10	0 %	0 %	8 %	25 %	67 %
	FS11	0 %	0 %	8 %	25 %	67 %
	FS12	0 %	0 %	0 %	25 %	75 %
Trust	FS13	0 %	0 %	17 %	66 %	17 %
	FS14	0 %	0 %	25 %	42 %	33 %
	FS15	0 %	0 %	8 %	50 %	42 %

From the results shown in this section, as in previous sections, we can also conclude that perceptions (in terms of ease of use, usefulness, and trust) are really positive for both the student and faculty surveys. Consequently, the proposed system had a great encouraging impact on the educational process from the point of view of both the student and faculty participants.

Conclusions

The use of Internet-based platforms to allow faculty to enhance classroom instruction is a field with a series of challenges to be overcome. In our particular case, the search for new solutions for developing e-learning systems to follow the progress of students and automatically assess the students' practical activities is essential within a higher educational system, this being especially true in the case of the EHEA. As a consequence, the main contributions of this work are the following. Firstly, we describe a service-oriented system to manage the self-evaluation and continuous assessment of the students' progress in the field of Information Technology, where activities measure practical daily-life skills, and some guidelines of how we are evolving the system in order to increase its general flexibility from our several years' experience. Therefore, the solutions of the associated practical activities to the service-oriented system are subjective. From our knowledge, there was not existing implementations to perform self-evaluation and continuous assessment of these types of activities. Secondly, this fact is even more important when using a distance methodology, as is the case of our University, since the number of students enrolled for each course can become elevated. The most immediate consequence is that the response time in checking the students' practical activities is minimized. In addition, automatic evaluation of practical activities allows faculty to reduce the time spent on this process and, thus, increase the time available for the dynamic adaptation of the learning process to students. They are also free to evaluate their progress in an immediate and reliable way, so they can independently go deeper in carrying out the practical activities, and it is not necessary to wait for their final evaluation. Thirdly, to conduct our research on the students' perceptions, we have chosen the NetServicesOS course, where students are expected to deploy and configure network services (DNS, DHCP, Web, etc.). Finally, the Technology Acceptance Model (TAM) is adapted to analyze the acceptance to use the system, in terms of ease of use, usefulness, and trust, for both student and faculty participants.

Within the scope of the activities that have been covered throughout the duration of this course, it has been particularly complex to develop the system due to the diversity of mechanisms involved in it (configuration files, software bases or implementation units) and the speed of software and operating system evolution. Therefore, we have implemented a solution that is as generic as possible, ignoring solutions that would tie us to using a specific software or version (that is difficult to change), which would not allow the system to evolve, as we have described above. The automatic evaluation part of the system allows us to define the requirements to be satisfied for each of the activities in a modular and expansible way. In order to adapt the activities to the system it is necessary to make a statement as specific as possible of those real-work practices, establish the evaluation elements, and the definition of them including the configuration files and templates to be used during the students' continuous assessment process. In addition, users of the system, the students in the initial scope of its application, are free to evaluate their progress in an immediate and reliable way, so they can independently go deeper in carrying out the practical activities. This fact enables the evaluation process to be automated and transferred to the students, and it is not necessary to wait for their final evaluation.

According to the data collected from the surveys, the student and faculty participants who evaluated the system found it significantly easier to use and useful for the purpose of dynamically following the students' progress and automatically evaluating their practical activities. Therefore, the system had a great positive impact on the educational process from the point of view of the student and faculty participants. It was also concluded that participants were confident with the system. In this sense, different results were described and more detailed conclusions were given in the corresponding sections for each statement. Finally, some participants suggested possible improvements for our proposed system, most of them have already been incorporated into it. In addition to this, the fact that our study only focused on users from one particular field of study, namely computer science, is a limitation. A possible future work would be focused on working with participants from other fields of study.

Acknowledgements

Authors would like to acknowledge the support of the following European Union project: MUREE (530332-TEMPUS-1-2012-1-JO-TEMPUS-JPCR); and a Local Project (2014-027-UNED-PROY) from the Spanish University for Distance Education. Furthermore, we thank the Region of Madrid for the support of E-Madrid Network of Excellence (S2013-ICE2715). Authors also gratefully acknowledge participants that took part in the surveys.

References

Agudo, J. M., Robles-Gómez, A., & Ros, S. (2011). *Management system of configuration and automatic evaluation for network services (In Spanish). Final Degree Project at the Computer Science School, UNED.* Madrid, Spain: Control and Communication Systems Department Projects.

Barry S. (2012). A video recording and viewing protocol for student group presentations: Assisting self-assessment through a Wiki environment. *Computers & Education, 59*(3), 855–860.

Belkin, N. J., Kelly, D., Kim, G., Kim, J.-Y., Lee, H.-J., Muresan, G., Tang, M.-C. M., Yuan, X.-J., & Cool, C. (2003). Query length in interactive information retrieval. In E. Clarke et al. (Eds.), *Proceedings of the SIGIR* (pp. 205–212). New York, NY: ACM Press.

Capra, R., Marchionini, G., Oh, J. S., Stutzman, F., & Zhang, Y. (2007). Effects of structure and interaction style on distinct search tasks. In E. Rasmussen et al. (Eds.), *Proceedings of the 7th ACM/IEEE-CS Joint Conference on Digital Libraries* (pp. 442–451). New York, NY: ACM Press.

Carswell, L., Thomas, P., Petre, M., Price, B., & Richards, M. (2000). Distance education via the Internet: The student experience. *British Journal of Educational Technology, 31*(1), 29−46.

Curlango-Rosas, C., Ponce, G. A., & Lopez-Morteo, G. A. (2011). A specialized search assistant for learning objects. *ACM Transactions on the Web, 5*(4), 1−29.

Dabbagh, N. & Kitsantas, A. (2012). Personal learning environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *Internet & Higher Education, 15*(1), 3–8.

Dagger, D., O'Connor, A., Lawless, S., Walsh, E., & Wade, V. P. (2007). Service-oriented e-learning platforms from monolithic systems to flexible services. *IEEE Internet Computing, 11*(3), 28–35.

Davis, F. D. (1993). User acceptance of information technology: System characteristics, user perceptions and behavioral impacts. *International Journal of Man–Machine Studies, 38*(3), 475–487.

De La Fuente-Valentín, L., Pardo, A., & Kloos, C. D. (2011). Generic service integration in adaptive learning experiences using IMS learning design. *Computers & Education, 57*(1), 1160–1170.

Douce, C., Livingstone, D., & Orwell, J. (2005). Automatic test-based assessment of programming: A review. *Journal on Educational Resources in Computing, 5*(3), 1–13.

Fishbein, M. & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Guerrero, J. F., Bataller, M., Soria, E., & Magdalena, R. (2007). Biolab: An educational tool for signal processing training in biomedical engineering. *IEEE Transactions on Education, 50*(1), 34–40.

Gutiérrez, E., Trenas, M. A., Ramos, J., Corbera, F., & Romero, S. (2010). A new Moodle module supporting automatic verification of VHDL-based assignments. *Computers & Education, 54*(2), 562–577.

Johnson, R. R. B. & Christensen, L. B. (2007). Educational research: Quantitative, qualitative, and mixed approaches. Thousand Oaks, CA: Sage Publications, Inc.

Liaw, S. -S. (2007). Investigating students' perceived satisfaction, behavioral intention, and effectiveness of e-learning: A case study of the Blackboard system. *Computers & Education, 51*(2), 864–873.

Liaw, S.-S. & Huang, H.-M. (2003). An investigation of user attitudes toward search engines as an information retrieval tool. *Computers in Human Behavior, 19*(6), 751–765.

Liu, I.F., Chen, M. C., Sun, Y. S., Wible, D., & Kuo, C. (2010). Extending the TAM model to explore the factors that affect intention to use an online learning community. *Computers & education, 54*(2), 600–610.

Lorenzo, E.J., Vélez, J., & Peñas, A. (2011). A proposal for automatic evaluation in a compiler construction course. In G. Rößling et al. (Eds.), *Proceedings of the 16th Annual Conference on Innovation and Technology in Computer Science Education* (pp. 308–312). New York, NY: ACM Press.

Morgan, Ch. & O'Reilly. (2002). *Assessing Open and Distance Learners.* London, United Kingdom: Kogan.

Morris, M., Morris, M. G., & Dillon, A. (1997). The influence of user perceptions on software utilization: Application and evaluation of a theoretical model of technology acceptance. *IEEE Software, 14*(4), 58–76.

Muñoz-Organero, M., Muñoz-Merino, P. J., & Kloos, C. (2010). Personalized service-oriented e-learning environments. *IEEE Internet Computing, 14*(2), 62–67.

Ngai, E. W. T., Poon, J. K. L., & Chan, Y. H. C. (2007). Empirical examination of the adoption of WebCT using TAM. *Computers & Education, 48*(2), 250–267.

Ong, C.-S., Lai, J.-Y., & Wang, Y.-S. (2004). Factors affecting engineers' acceptance of asynchronous e-learning system in high-tech companies. *Information and Management, 41*(6), 795–804.

O'Reilly, T. (2007). What is Web 2.0: Design patterns and business models for the next generation of software. *International Journal of Digital Economics, 65*, 17–37.

Pan, C.-C., Gunter, G., Sivo, S., & Cornell, R. (2005). End-user acceptance of a learning management system in two hybrid large-sized introductory undergraduate courses: A case study. *Journal of Educational Technology Systems, 33*(4), 355–365.

Persico, D., Manca, S., & Pozzi, F. (2014). Adapting the technology acceptance model to evaluate the innovative potential of e-learning systems. *Computers in Human Behavior, 30*, 614-622.

Pituch, K. A., & Lee, Y.-K. (2006). The influence of system characteristics on e-learning use. *Computers & Education, 47*(2), 222–244.

Raaij, E. M. V. & Schepers, J. J. L. (2008). The acceptance and use of a virtual learning environment in China. *Computers & Education, 50*(3), 838–852.

Robles-Gómez, A., Tobarra, L., Ros, S., Hernández, R., Caminero, A. C., Pastor, R., & Castro, M. (2011, April). Proposal of an Auto-Evaluation Framework for the Learning of Network Services. In A. Y. Al-Zoubi et al. (Eds.), *Global Engineering Education Conference (EDUCON), 2011 IEEE* (pp. 392–396). Amman, Jordan: IEEE Education Society.

Ryan, S., Scout, B., Freeman, H., & Patel, D. (2000). The virtual university: The Internet and resource-based learning. London, United Kingdom: Kogan.

Schrum, L., Burbank, M. D, & Capps, R. (2007). Preparing future teachers for diverse schools in an online learning community: Perceptions and practice. *Internet & Higher Education, 10*(3), 204–211.

Wilson, S., Liber, O., Johnson, M., Beauvoir, P., Sharples, P., & Milligan, C. (2006). Personal learning environments: Challenging the dominant design of educational systems. *Lecture Notes in Computer Science, 4227*, 173–182.

Yi, M. Y., & Hwang, Y. (2003). Predicting the use of web-based information systems: Self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model. *International Journal of Human–Computer Studies, 59*(4), 431–449.