

RESEARCH ARTICLE

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# The impact of usable system for regression analysis in higher education

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## Abstract

In Mexico, both universities and professors are changing the teaching-learning process in order to improve the conditions that prevail in the classroom. These modifications are making instructors include the usage, planning, organization, and construction of various technological applications in their activities. This research proposes the design and implementation of System Usable for Regression Analysis (SUAR), the purpose of which is to customize the audiovisual content taking into account the characteristics and abilities of the students. In particular, this system adjusts the information considering the level of knowledge of the estimation of prediction and visual or auditory learning styles by the adaptation, content, and evaluation modules. This study is based on the quantitative approach to analyze the academic performance of 14 students taking the System Design course during the school year 2015-I. The ANOVA method with the significance level of 0.05 and 0.025 assess the impact of SUAR during this course accomplished at a university in the south of Mexico City. Finally, this investigation proposes to build web systems that consider SUAR architecture and usability to enhance the educational context.

**Keywords:** Computer-assisted instruction, Online learning, Distance learning, Usability

## Introduction

Today, universities in Mexico are modifying their activities, methodologies and processes of teaching-learning in order to meet the demands of the students in the XXI century. To perform these transformations efficiently, the colleges analyze the prevailing conditions in the environment to redefine the people's profile involved in education. In particular, Monereo & y Domínguez (2014, p.86) state that the teacher should develop "innovation competition which includes actions such as the inclusion of changes that optimize the educational process, analysis, inquiry and reflection on one's own experience or participation in projects and quality improvement".

According to Vázquez García (2015), one of the global trends that is influencing higher education is the online component, which involves the use of the network, Internet and new technologies for personalized information. Similarly, Ariza and Quesada (2014) explain that there is a growing tendency among professors regarding the use of technological tools which highlights the importance of the digital material's design (videos, tutorials and assessment questions banks) to acquire and to achieve lasting and transferable knowledge.

Hepp, Prats Fernández, and Holgado Garcia (2015) established that the new learning scenarios have a transformative perspective that includes the training of tutors in relation to the educational innovations and technology where digital, open, flexible, creative, real, and participatory projects are incorporated. Also, Ongun and Demirag (2015) claim that students using multimedia resources can significantly plan their tasks through the use of visual and audio tools.

In fact, instructors get involved every day in the aspects of planning, evaluation and implementation of various software applications used in the classroom, where the aspect of usability has a preponderant importance to facilitate the assimilation and reuse of knowledge.

With this background in mind, during the 2015-I cycle, the “Systems Design” course educator has decided to build the System Usable for Regression Analysis (SUAR) in order to evaluate the teaching-learning process about the design of intelligent applications.

This study is structured as follows: the importance of usability is reviewed in the first section and the following sections describe the methodology, results, and conclusions of this investigation.

## **Usability**

González and Farnós (2009) mention that usability refers to the degree of ease in the use of a type of product (technology) and satisfaction generated in the people characterized by the speed of access and understanding. Similarly, Ruiz et al., (2006 p.27) explain that the ISO/IECE 9126 rule states that “usability is the ability of a software product to be understood, learned and attractive to the people when it is employed under specific conditions”.

According to Turpo Gebera (2012), it is essential to consider usability during the organization, the development, and the evaluation of an online training to ensure student learning and the quality of the resources. Alva (2005) suggests the analysis of usability for online academic resources through three dimensions: navigation, design, and content (see Table 1).

Mascheroni, Greiner, Dapozo, & y Estayno (2013 p.126) indicate that Usability Engineering (UI) can be defined as “a set of techniques for the development of systems in which is specified the quantitative levels of utility and is constructed to achieve those levels, known as metrics”. Table 2 shows the stages of UI.

Finally, Leavitt and Shneiderman (2006) explain that the guidelines of the US Department of Health and Human Services (HHS) contain the most important features of international standards of usability for web design. In particular, the category called Process of design and evaluation allows one to analyze the use of the content for the audience, to identify the needs of the last user, to determine the interaction with the user and to assess the technological advances.

## **Methodology**

This research is based on the quantitative approach in order to analyze the academic performance of students before and after using the SUAR in the Systems Design course. According to Giroux and Tremblay (2004), this approach allows for the analyzing of the phenomena through measurement and data analysis with numbers. Furthermore Newbold, Carlson, and Thorne (2008) explained that the quantitative data have measurable meaning, which can be calculated at intervals and reasons.

**Table 1** Dimensions for usability analysis

No	Navigation	Design	Content
1	Moving between pages of the site	Types of messages	Release date
2	Friendly navigation	Equality use	Bug free
3	Links and labeling	Flexibility	Content adjusted to the pedagogical level
4	Ease of user location	Simple and intuitive	Links to information sources
5	Ease of sending and receiving	Appropriate dimensions	Name and credentials of the author
6	Visible and easily identifiable options	Fault tolerant	Specific frames
7	Simple language	Little physical effort	Content in perspective and without distortion
8		Perceptible information	Minimization of the use of notifications
9			Learning objectives
10			Learning path
11			Previous knowledge required
12			Learning levels

According to Keller (2012), inferential statistics is the process of making an estimate, prediction, or decision about a population based on a sample. Similarly, Casas Sánchez (2010), p.20) states that “when a sample of a population is selected, a key objective is to make inferences about population characteristics or draw conclusions that are valid for the entire population”.

In this research, the sample consisted of 14 students enrolled in the Systems Design course during the school year 2015-I where SUAR is used to present the content about the regression analysis for the construction of intelligent systems. It is noteworthy that it determines the correlation between different variables in order to estimate the prediction through different types of mathematical models as linear or quadratic (Walpole, Myers, Ye, & y Myers, 2012).

The general objective of this investigation is: design, implement and evaluate the SUAR in the Systems Design course during the 2015-I cycle.

**Table 2** Stages of usability engineering

Stage	Element	Description
Specifications	Users' analysis	It is done to identify the users and their tasks, and the way they carry them out
	Task Identification	It is a set of techniques used to determine how users perform a specific task
	Specifying usability	It refers to a series of usability specifications
Design	Interaction design	It includes a conceptual system and a visual interaction design
	Prototype	Precise system prototypes are used to be easily understood by the user
	User's participation	The participation at this stage can vary according to the degree of involvement, providing a User Centered Design (UCD) or Participatory Design (PD)
Evaluation	Usability testing	It shows the user a set of tasks to be performed with the previously designed prototype, compiling their actions and evaluation to be analyzed later
	Heuristic evaluation	This evaluation is based on experience of design or usability guidelines to point out the mistakes in the system

The specific objectives for this research are: design the SUAR considering the aspect of usability, implementing SUAR in the Systems Design course during the school year 2015-I, and assess the impact of SUAR during the process of teaching-learning through the ANOVA method.

Anderson, (Anderson, Sweeney, & Williams, (2008):497) state that the ANOVA method “allows the obtaining of two independent estimates of the common population variance  $\sigma^2$ . One estimate of  $\sigma^2$  is based on the variability between the sample means and the variability between each sample data”.

The independent variable for this investigation is the SUAR and the dependent variable is related to the student's performance (grade). The research's tool consists of two questionnaires about the design of intelligent systems considering regression analysis, which are used before and after the students employ this technological tool. Figure 1 shows the questionnaire used to retrieve information about the students before and after using the SUAR.

Furthermore, this study used a questionnaire to retrieve student impressions on the aspect of usability used in the SUAR (See Table 3).

The hypotheses of this investigation are:

Null hypothesis (Ho): The SUAR does not facilitate the teaching-learning process related to the design of intelligent systems.

Alternative hypothesis (Ha): The SUAR facilitates the teaching-learning process related to the design of intelligent systems.

## Results

Figure 2 shows the web interface SUAR built through HTML5 to facilitate the access of information. According to Punín, Martínez, and Rencoret (2014), HTML5 (Hyper Text

Quiz 1

Course: Systems Design  
 Name of teacher:  
 Evaluating units: Date of application:  
 Name of student:

General information: The duration of the test is 60 minutes. The examination consists of 5 questions about the design of intelligent systems. Each question has the value of 2 points.

You are responsible for making the design of a system whose aim is to predict sales. Uses linear regression analysis and make the following diagrams:

- 1.- Make the package diagram of the intelligent system (2 points).
2. - Make the use case diagram of the intelligent system (2 points).
3. - Make the activity diagram of the intelligent system (2 points).
4. - Make the sequence diagram of the intelligent system (2 points).
5. - Make the communication diagram of the intelligent system (2 points).

**Fig. 1** Quiz 1 used on this research. The questionnaire of this research consists of five questions related to the design of intelligent systems

**Table 3** Elements of the questionnaire on usability

No	Categories	Variable name	Content	Measurement scale	Modalities or value	Code
1	Utility	Contents	Audiovisual content facilitates the teaching-learning process related to prediction	Ordinal	Strongly agree	1
2	Utility	Personalization	Customization of audiovisual content facilitate the teaching-learning process	Ordinal	Somewhat agree	2
3	Navigation	Web interface	The navigation of the web interface is easy	Ordinal	Neither agree nor disagree	3
4	Design	Spanish language	Audiovisual content employing audio in Spanish facilitates the teaching-learning process	Ordinal	Somewhat disagree	4
5	Design	English language	Audiovisual content employing audio in English facilitates the teaching-learning process	Ordinal	Strongly disagree	5

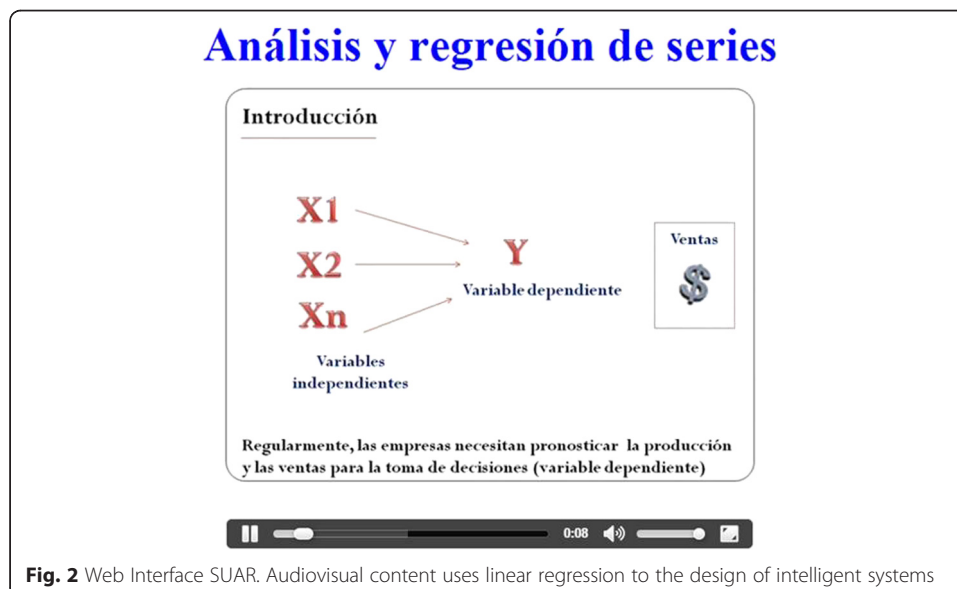
Markup Language) allows for the creating of usable web sites through the flexibility of operating systems and browsers.

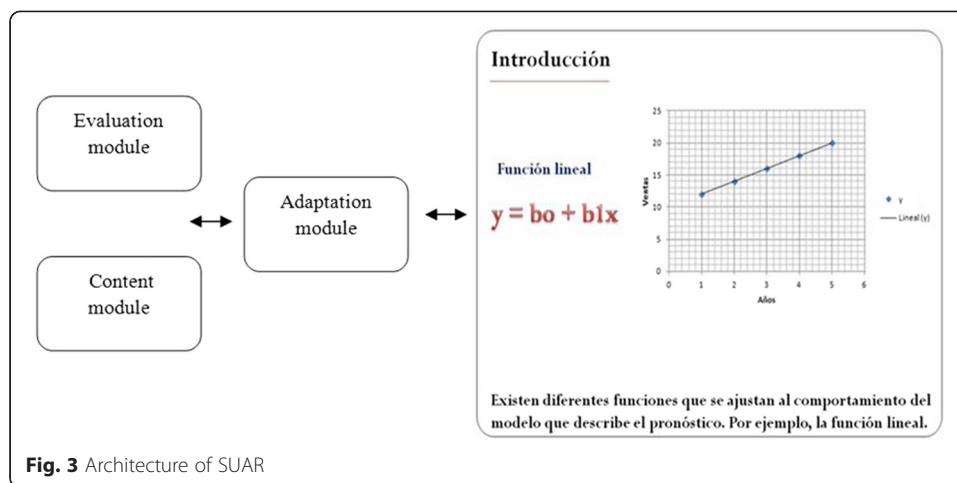
Figure 3 shows the SUAR architecture composed of Adaptation, Content, and Evaluation modules.

Adaptation module receives information from the evaluation module to select audiovisual content that adjust to the students' profile. Figure 4 presents the questionnaire used by the evaluation module to identify the level of knowledge and the visual or auditory learning styles.

The content module stores information about regression analysis considering the user's profile. For example, the visual or auditory learning styles are personalized through subtitles and audio in Spanish and English. Figure 5 shows an example of audiovisual content used by the SUAR.

Table 4 shows the objectives that are included in the category called Process design and the evaluation of HHS, which are used during the planning and construction of SUAR.

**Fig. 2** Web Interface SUAR. Audiovisual content uses linear regression to the design of intelligent systems



The ANOVA method allows this research to understand the behavior presented by 14 students before and after using the SUAR with a significance level of 0.05 and 0.025. Table 5 shows the results obtained using the spreadsheet to use this method

Table 5 shows that the F (17.27) value is greater than the critical values of 0.05 (4.225) and 0.025 (5.658). Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted, which states that the SUAR improves the process of teaching-learning related to the design of intelligent systems using regression analysis to calculate the prediction.

Figure 6 shows the academic performance presented by the 14 students who completed the Systems Design course in the 2015–1 school year before and after using the SUAR.

For the analysis of the aspect of usability, this research was based on the following scale: Strongly agree (1) and strongly disagree (5). Table 6 shows the percentages obtained from the categories of utility, navigation, and design.

Table 6 shows that the prevailing opinion of the 14 students regarding the three aspects of usability composed of the utility, navigation, and design categories is in the somewhat agree scale.

### Análisis y regresión de series

**INSTRUCCIONES**  
Contesta las siguientes preguntas

- ¿Deseas el contenido sobre la introducción para calcular el pronóstico?  
☒ Si  
☐ No
- ¿Deseas el contenido sobre el modelo para calcular el pronóstico?  
☒ Si  
☐ No
- ¿Deseas el contenido sobre el ejercicio práctico para calcular el pronóstico?  
☒ Si  
☐ No
- Indica el idioma de la voz para los contenidos audiovisuales  
☒ Español  
☐ Inglés  
☐ Ninguno
- Indica el idioma de los subtítulos para los contenidos audiovisuales  
☒ Español  
☐ Inglés  
☐ Ninguno

Error

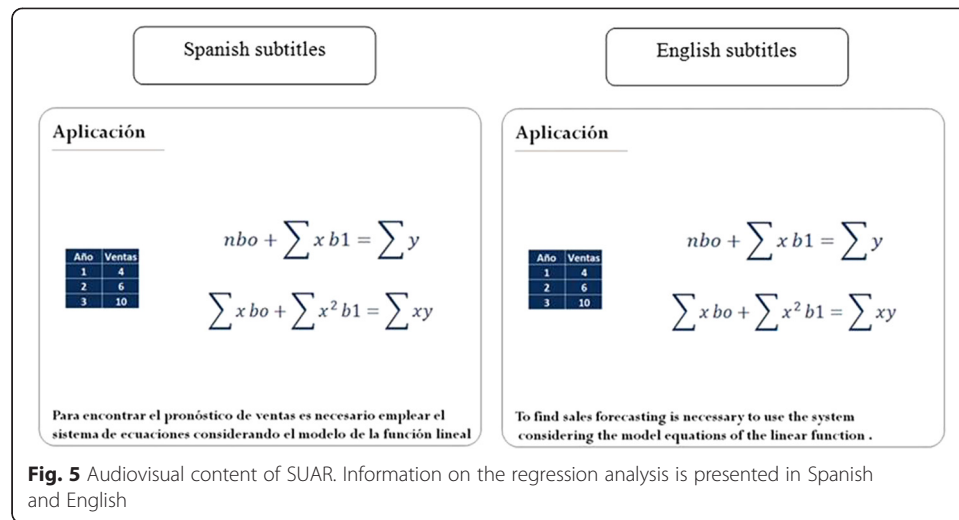
$$(y - b_0 - b_1x)^2$$

↑  
Valor  
observado

↓  
Valor  
estimado

The graph shows 'observado' (observed) values as blue diamonds and 'aproximado' (approximated) values as red diamonds. The x-axis represents time (1 to 3) and the y-axis represents values (0 to 12). A linear regression line is shown, and the error is calculated as  $(y - b_0 - b_1x)^2$ .

**Fig. 4** Questionnaire used by the SUAR. The questionnaire results offer students information according to your needs



## Conclusion and discussion

Nowadays, universities face new challenges related to the teaching-learning process where the design and implementation of cutting-edge technology is fundamental to meet the educational demands of the XXI century. Indeed, Pérez and Delgado (2012) mention the importance and necessity of undertaking various educational procedures in order to create competent individuals.

As reported by Rodríguez Aguilar, Castillo González, and y Liria Campos (2013), the success of significant learning through the use of ICT is related to the figures, images, animations and simulations on the web interface. In particular, the adaptation of content refers to the dynamic presentation of web pages (text, audio, sound, video and animation) taking into account the level of knowledge, goals and user characteristics (Kazanidis & Satratzemi, 2007).

Therefore, the responsibilities, functions and activities of the professor are changing in order to improve the teaching-learning process. One aspect that allowed the realization of these modifications is the training of tutors in the aspects related to computer and instructional design.

This research proposes the design of a usable system for regression analysis (SUAR) to facilitate the assimilation and reuse of knowledge about the planning of intelligent systems dedicated to prediction. The adaptation module manages the presentation of the audiovisual content that the student needs through the selection of the level of knowledge, subtitles and audio in Spanish and English.

González Vidal and y Blanco Encinosa (2012) explain that adaptation refers to the ability of a system to meet the needs and requirements of the user. Furthermore, the Content

**Table 4** Objectives of the design process and evaluation of HHS

No	Objective	Use in SUAR
1	Provide useful content	Audiovisual content considered the issues related to the regression analysis used in the design of intelligent web systems.
2	Establish user requirements	The requirements are related to the student's learning style and his or her level of knowledge.
3	Consider the diversity of the interface	Programming in HTML5 enables flexibility in the browsers and operating systems used by the student



**Table 5** ANOVA with a significance level of 0.05 and 0.025

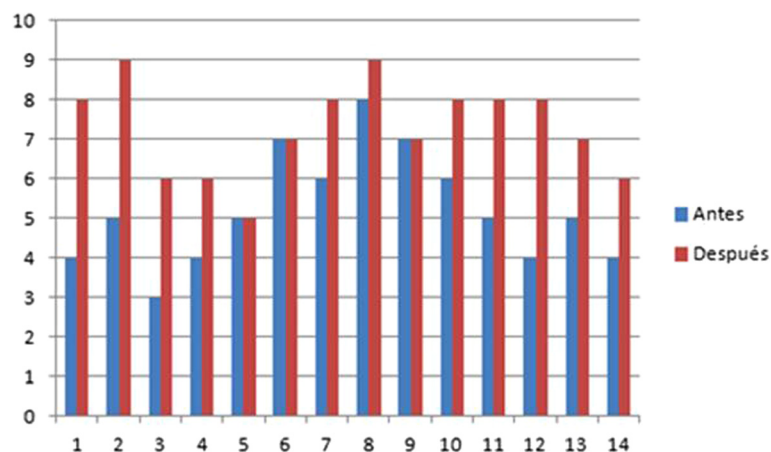
Origin of variations	Sum of squares	Degrees of freedom	Average squares	F	Critical value for F ( $\alpha = 0.05$ )	Critical value for F ( $\alpha = 0.025$ )
Among groups	30.0357143	1	30.0357143	17.271722	4.225	5.658
Within groups	45.2142857	26	1.73901099			

module stores information about the calculation of the prediction and the Questionnaire module evaluates the demands of the student to determine the user's profile

During the construction of SUAR, the aspect of usability has a fundamental role in improving the educational conditions. According to Salaverría (2005), the great challenge of building web educational systems in the XXI century is to consider the aspect of usability. In this investigation, the needs and characteristics of students are used for analysis and identification, with the objective of personalizing the audiovisual content. On top of that, the web interface design considers factors of navigation to transmit knowledge about regression analysis in a quick, easy and intuitive. Similarly, Buitrón de la Torre M (2004) explains that building web systems is related to the ease of access and interaction through usability, which he considers as fundamental factors associated with people, tasks and context.

Through the quantitative approach, this study argues that the SUAR improves the learning conditions for students. In particular, the ANOVA method with a significance level of 0.05 and 0.025, analyzed 14 students who took the Systems Design course during the 2015-I cycle where a significant change occurred in the grade on the test (dependent variable) regarding the use of case, communication, activities, sequence and package diagrams focused on the prediction. As a matter of fact, Elizondo López (2002) explains that the experimental method is based on the deliberate production of phenomena to analyze their characteristics.

This research recommends building the web interface using HTML5 language to improve access to audiovisual content through the flexibility of the browsers and the operating systems. Meyer (2010) explains that HTML5 is changing the way transmitting information over the Internet is done because media products are efficiently spread



**Fig. 6** Grades obtained by students. SUAR facilitates the process of teaching and learning related to the design of intelligent systems



**Table 6** Results of usability

Scale	Utility	Navigation	Design
Strongly agree (1)	35.71 %	35.71 %	28.57 %
Somewhat agree (2)	42.86 %	57.14 %	64.29 %
Neither agree nor disagree (3)	21.43 %	7.14 %	7.14 %
Somewhat disagree (4)	0.00 %	0.00 %	0.00 %
Strongly disagree (5)	0.00 %	0.00 %	0.00 %

throughout various browsers (Internet Explorer, Firefox, Opera, and Chrome) and operating systems (Linux, Mac and Windows).

Similarly, this study suggests considering the characteristics of students (visual or auditory) during the planning of web-based educational systems to present information that meets their needs and expectations. Also, the aspect of usability acquires a fundamental role in the design of the teaching-learning applications because it creates nice, simple and useful virtual spaces for pupils. As Rubin and y Chisnell (2008) mentioned, usability is related to the degree to which the user achieves its objectives (utility).

This research suggests that during the design and planning of educational systems Web Adaptation, Content and Evaluation modules should be considered in order to facilitate the assimilation and reuse of knowledge. In particular, the Adaptation module presents the information according to the characteristics and needs that students have, the content module stores the data of the course and the evaluation module determines the material that the student needs through the questionnaire. Also, usable web interface allows users to receive information demanded by the customizing audiovisual content. During the system construction, it is necessary the aspects of usability related to the utility, navigation and design to be analyzed in order to create a web interface that meets the requirements of individuals. In this study, the utility is linked to content and personalization, navigation refers to the web interface and design refers to the use of Spanish and English language. 35.71 % of students consider that the aspects of utility and navigation are in Category 1 (strongly agree) while 28.57 % placed the design in this classification.

Note that in this investigation, the results related to usability for SUAR show that the utility (42.86 %), navigation (57.14 %) and design (64.29 %) are placed in Category 2 (somewhat agree). Therefore, SUAR architecture will be improved through the use of info graphics in order to increase the percentages obtained in Category 1 (strongly agree). Of the 14 students, 12 pupils improved their qualifications related to the design of intelligent systems and 2 obtained the same results. Through the use of the ANOVA method a value of  $F(17.27)$  was obtained, which is greater than the critical values of 0.05 (4.225) and 0.025 (5.658). Therefore, the alternative hypothesis which states that the SUAR improves the process of teaching-learning related to the design of intelligent systems is accepted.

In conclusion, this study examines the design and implementation of the SUAR architecture consisting of the Adaptation, Questionnaire and Content modules to facilitate the transfer, assimilation, and reuse of knowledge explained in the classroom. In particular, this system personalizes audiovisual content in Regression Analysis to improve the teaching-learning process during the construction of intelligent applications.

**Competing interests**

The author declares that he has no competing interests.

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