INVESTIGACIÓN/RESEARCH

USE OF INFOGRAPHICS IN VIRTUAL ENVIRONMENTS FOR PERSONAL LEARNING PROCESS ON BOOLEAN ALGEBRA

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ABSTRACT

The cutting edge technology opens new opportunities to plan and implement various teaching strategies in virtual environments that enable the efficient development of competence in students. Therefore, universities face the challenge of implementing innovative technological tools in the educational process to facilitate the assimilation and utilization of knowledge. In particular, the professor of Computational Mathematics course 2014-II has decided to use the infographics during the construction of audiovisual contents presented by the Usable Adaptive Hypermedia System (SHAU) in order to improve the communication channel between the web interface and the user. This system customizes the information considering the level of knowledge possessed by students on Boolean algebra and styles of visual - auditory learning. The quantitative approach through ANOVA method allows this research to analyze the development of knowledge of the 30 students before and after using the SHAU 2.0. Finally, the results confirm that the use of the infographics with the latest technology facilitates the learning process through the construction of audiovisual contents based on Graphic Design.

USO DE LA INFOGRAFÍA EN LOS ENTORNOS VIRTUALES PERSONALIZADOS PARA EL PROCESO DE ENSEÑANZA-APRENDIZAJE SOBRE EL ÁLGEBRA BOOLEANA

RESUMEN

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Los avances que presenta la tecnología de vanguardia abren nuevas oportunidades para planear e implementar diversas estrategias pedagógicas en los entornos virtuales que permitan el desarrollo eficiente de las competencias en los estudiantes. Por consiguiente, las universidades enfrentan el reto de implementar innovadoras herramientas tecnológicas en el proceso de enseñanza-aprendizaje para facilitar la asimilación y utilización del conocimiento. En particular, el docente encargado de la asignatura Matemáticas Computacionales en el ciclo escolar 2014-II ha decidido utilizar la infografía en los contenidos audiovisuales que presenta el Sistema Hipermedia Adaptativo Usable (SHAU) con el propósito de mejorar el canal de comunicación entre la interfaz web y el usuario. Este sistema personaliza la información considerando el nivel de conocimiento que posee los estudiantes sobre el Álgebra Booleana y los estilos de aprendizaje visual-auditivo. El Enfoque cuantitativo a través del método ANOVA permite a esta investigación analizar el desarrollo del conocimiento de los 30 estudiantes antes y después de utilizar el SHAU 2.0. Finalmente, los resultados obtenidos permiten afirmar que el uso de la infografía junto con la tecnología de punta facilita el proceso educativo por medio de la construcción de los contenidos audiovisuales en base al Diseño Gráfico.

PALABRAS CLAVES
Tecnología – Infografía – Sistemas web usables – Educación – Usabilidad – Interfaz web – Proceso de enseñanza-aprendizaje – Accesibilidad

1. INTRODUCTION

Currently, universities along with teachers face the challenge of improving the educational context. To this end, cutting edge technology and pedagogical strategies open up the possibility of designing new virtual environments that facilitate the optimal development of competence in students. Regularly, pupils have trouble matching and using the theoretical content taught in the classroom with the productive activities carried out in companies. This barrier causes people can't be incorporated effectively in the workplace.

For this reason, the teacher in charge of Computational Mathematics course design the Usable Adaptive Hypermedia System (SHAU 2.0) considering the infographics in order to facilitate understanding of the theoretical information.

According to Smiciklas (2012), infographics is an image that combines design information to efficiently communicate the message to the audience. The benefits include understanding of ideas and concepts, the increase in the ability to think critically and improving data retention.

This research analyzes the academic achievement of students before (pre-test) and after (post-test) using the SHAU 2.0 during the educational process related to Boolean algebra.

2. OBJECTIVES

The overall objective of this research is:
- Design and implement audiovisual contents via infographics in SHAU 2.0

The specific objectives are:
- Designing audiovisual contents related to Boolean algebra through infographics
- Implement audiovisual contents created by infographics in SHAU 2.0
- Evaluate the academic performance of students taking the course of Computational Mathematics 2014-II before (pre-test) and after (post-test) using the SHAU 2.0

The following section describes the background associated with SHAU 1.0 and infographics which are used during the construction of audiovisual contents.

3. SHAU 1.0

In 2013 is designed SHAU, which presents audiovisual contents on Boolean algebra considering the aspects of knowledge level and learning style that has the student. The SHAU 1.0 is designed by means of usability, accessibility, aesthetics and adaptation module. It is noteworthy that this system has the public register of copyright number: 03-2014-092511130000-01.

The usability allows users to navigate in a fast, simple and intuitive web interface where audiovisual contents as logic gates, digital circuits, truth tables, output functions and Karnaugh maps are presented. Thurow and Music (2009) explain that a website is usable if users do not encounter obstacles to obtain what they want to meet their needs.

Accessibility gives users flexibility in the use of operating systems and web browsers. For example, HTML5 allows people to access information without the need to download plug- ins. As reported Kurniawan and Zaphiris (2007), web accessibility refers to obtain and use information and services regardless of the access technology used.

The adaptation module SHAU 1.0 determines learning style and level of knowledge possessed by the student on Boolean algebra in order to customize the information. Koutri, Avouris and Daskalaki (2005) explain that the phases employing adaptive hypermedia system are collecting student data, processing the data to build the user model and implementation.

Aesthetics provides order and structure to the elements of the web interface through the lattice, the readability and the appropriate use of color to create a nice virtual environment.

Lawrence and Tavakol (2007) mention that the methodology of web design consists of three pillars: usability, aesthetic and purpose. Figure 1 shows the most relevant aspects of the construction employed for SHAU 1.0.
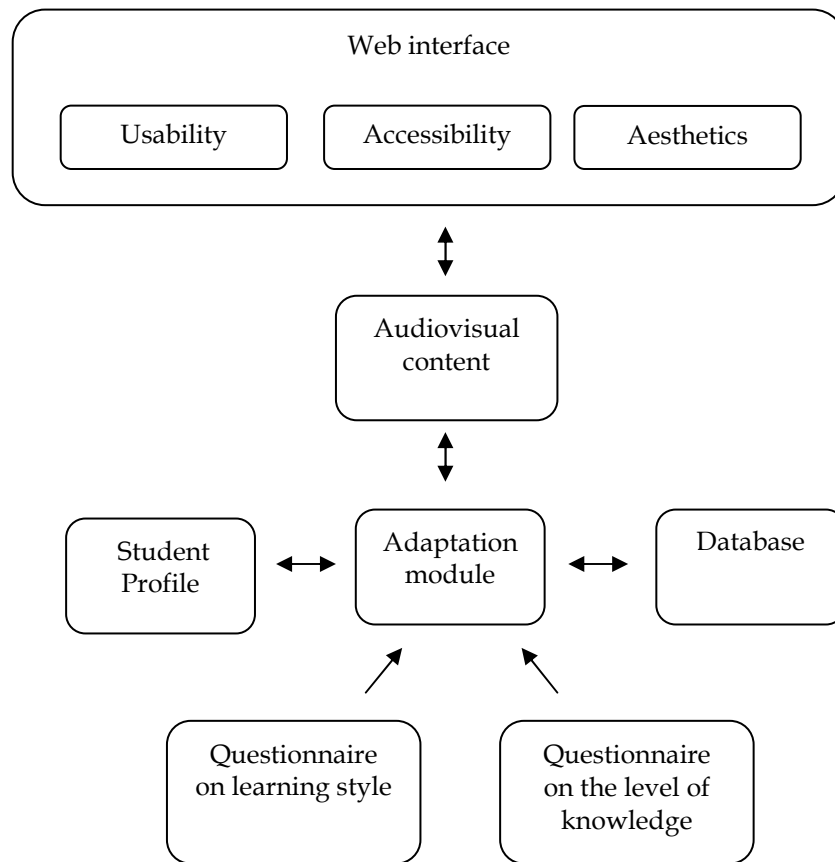
Figure 1: **Architecture SHAU 1.0**
Source: Own design, 2014

To improve the teaching – learning process of Boolean algebra, the teacher in charge of the subject of Computational Mathematics has decided to use infographics for design and construction of audiovisual contents in SHAU.

4. INFOGRAPHY

According to Gamonal (2013, p. 335), "the infographic goes beyond the mere creation of graphics. Its main goal is to turn the complex into simple and explain how difficult the clearest possible way using the graphical language ". For this reason, this research is interested in meeting the academic performance of students using infographics for the design of audiovisual contents of SHAU.

Valero (2009) states that digital infographics is a form of visual and informative content, communication reproduced in the media in order to facilitate the understanding of information.

Also Said (2010 , p.197) explains that " the infographic is a summation of several elements at different times of production , news, designers, journalists, images, text, internet, production techniques, online media and performers who make up a larger image as an information unit called digital infographics".

The digital infographics enables this research propose the design of new pieces of information that will improve the educational process related to Boolean algebra considering the level of knowledge and style of visual or auditory learning that students present .

For the construction of infographics, Smiciklas (2012) explains that it is necessary to consider the following: who is the audience, what is the purpose of infographics, when relevant information, where information comes from, why publication is important for the audience and how easy is information to be understood.

Castañeda (2013) undertook a project to study infographics contained in the 32 virtual courses in the subjects of Social and Legal Sciences of the University of the Vasco. Through this study concluded that the use of infographics is very low (1%) compared to other types of didactic images.

Therefore, this research is relevant to the analysis of the use of infographics in virtual environments.

5. METHODOLOGY

This research is based on quantitative approach in order to analyze the behavior presented by 30 students taking the subject Computational Mathematics at a university located south of Mexico City during the 2014 - II school year. Through ANOVA is analyzed the behavior of pupils before (pre-test) and after (post-test) using the SHAU 2.0 as technological resource to support classroom course.

The independent variable is the SHAU 2.0 and the dependent variable is related to academic achievement of students related to Boolean algebra. The instruments used in this research are composed of two questionnaires (25 questions) to collect data before and after using the web system.

The hypotheses used in this research are:
- Null hypothesis (Ho): The design of audiovisual contents via infographics in SHAU 2.0 does not facilitate the teaching- learning Boolean algebra
- Alternative hypothesis (Ha): The design of audiovisual contents via infographics in SHAU 2.0 facilitates the process of teaching and learning on Boolean algebra

The following section describes SHAU 2.0 architecture and presents the results obtained during implementation in the teaching-learning process.

6. RESULTS

The incorporation of infographics in the web system gave rise to SHAU 2.0 which purpose is to facilitate the teaching - learning Boolean algebra through the design of audiovisual contents supported in Graphic Design. Figure 2 shows the architecture of SHAU 2.0.
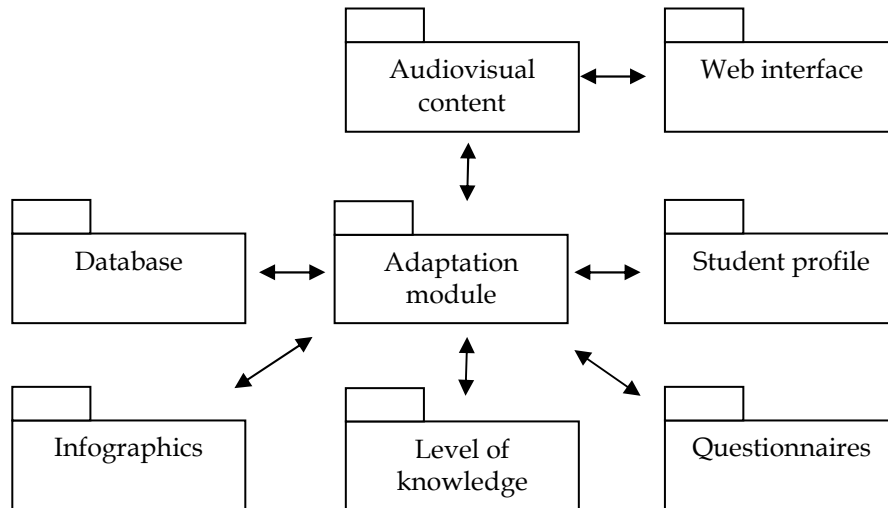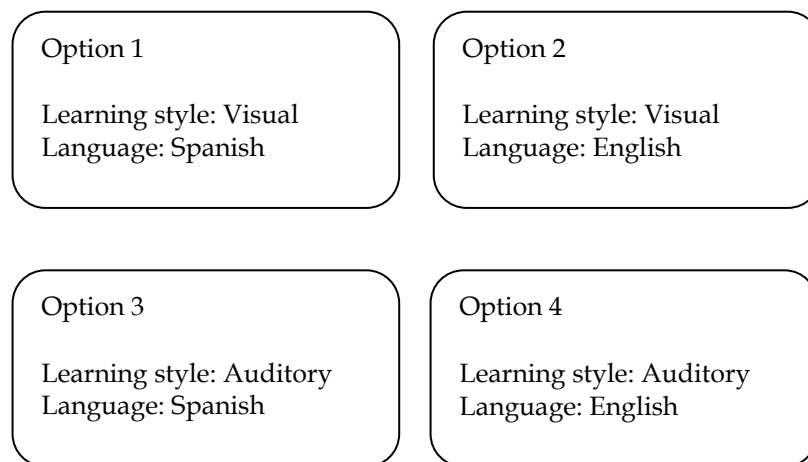

Figure 2: **Architecture SHAU 2.0**
Source: Own design, 2014

In Figure 2, the adaptation module controls the audiovisual contents on Boolean algebra considering the student profile, infographics and level of knowledge.
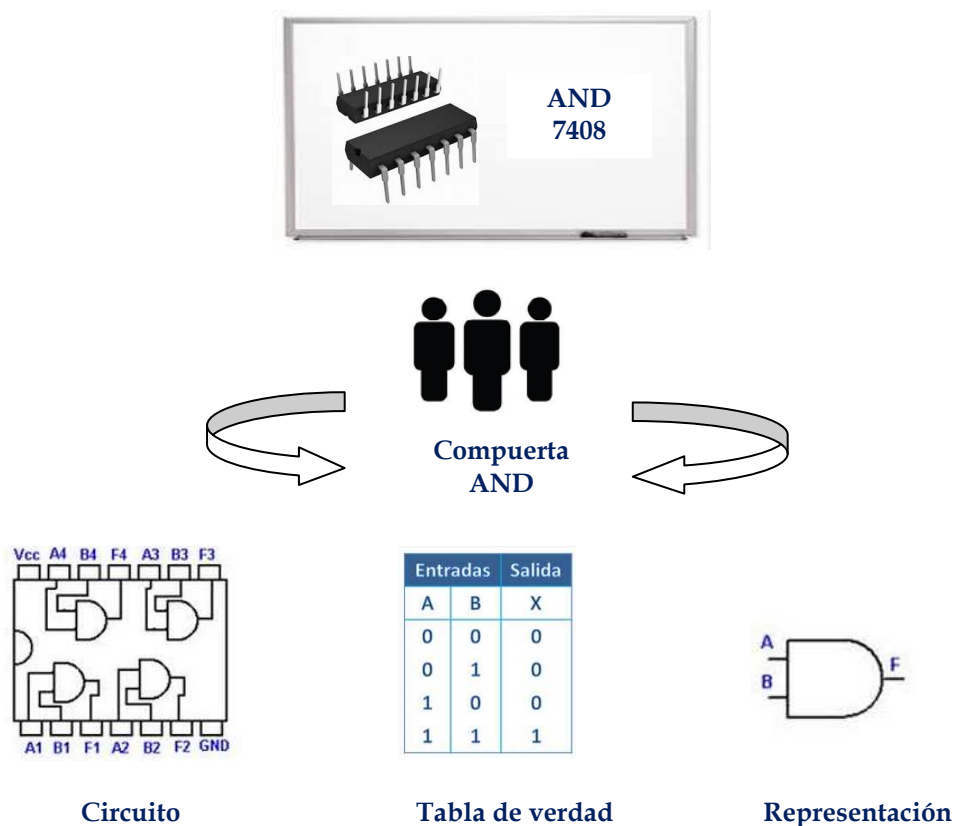
Figure 3 shows the different ways of presenting infographics according to the characteristics of students.

Figure 3: **Infographics in SHAU 2.0**
Source: Own design, 2014

Figure 4 shows an example of the use of infographics about the AND gate.

Figure 4: **Infographic of the gate And in SHAU 2.0**
Source: Own design, 2014

The SHAU 2.0 controls five units on Boolean algebra related topics: logic gates, output functions, Karnaugh maps, applications and breadboard. Table 1 shows the infographics designed by thematic unity.

Table 1
Description of infographics in SHAU 2.0

No	Unit	Description of infographics
1	1.1	Using the AND gate
2	1.2	Using the OR gate
3	1.3	Using the NOT gate
4	2.1	Importance of output functions
5	2.2	Steps to find the output function
6	3.1	Karnaugh maps
7	4.1	Applications : Sensors
8	4.2	Applications: Decoder
9	4.3	Applications: Multiplexer
10	5.1	Items used in the breadboard

Figure 5 shows the infographic for unit 5 about elements used in the breadboard.
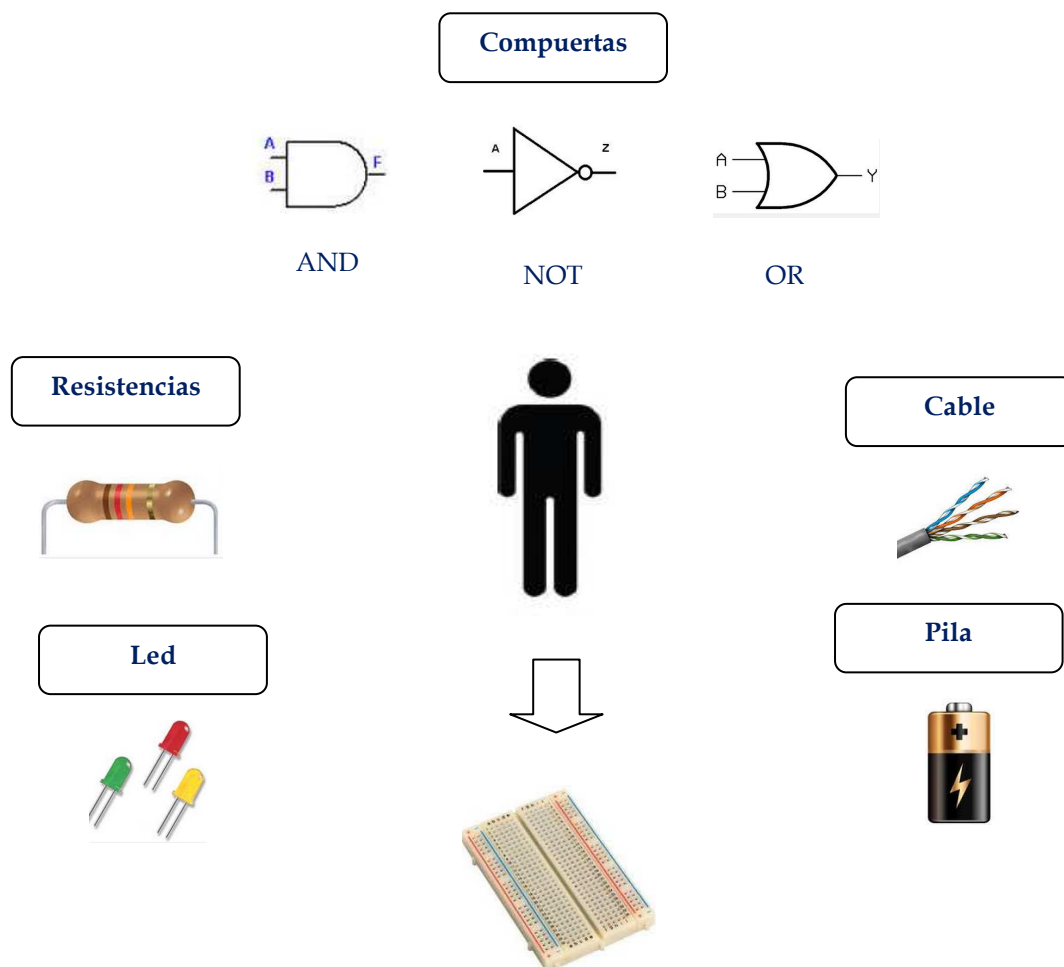
Figure 5: **Infographic on the breadboard in SHAU 2.0**
Source: Own design, 2014

The results obtained using the ANOVA method with significance level of 0.05, 0.025 and 0.01 during this investigation are shown.

Table 2 shows that the null hypothesis is rejected because the value of F (86.3) is higher than the critical value (4.0068). Therefore, the use of infographics in SHAU 2.0 enhances the teaching-learning process.

Table 2
ANOVA with significance level 0.05

Origin of variations	Sum of squares	Degrees of freedom	Average squares	F	Probability	Critical value for F
Among groups	141.066667	1	141.066667	83.6021798	7.6962E-13	4.00687282
Within groups	97.8666667	58	1.68735632			

Likewise, Table 3 shows ANOVA with significance level of 0.025 reject the null hypothesis with an increased value of F (83.6) compared with the critical value (5.29).

Table 3
ANOVA with significance level 0.025

Origin of variations	Sum of squares	Degrees of freedom	Average squares	F	Probability	Critical value for F
Among groups	141.066667	1	141.066667	83.6021798	7.6962E-13	5.29498567
Within groups	97.8666667	58	1.68735632			

Finally, Table 4 presents the results of the ANOVA method with significance level of 0.01.

Table 4
ANOVA with significance level 0.01

Origin of variations	Sum of squares	Degrees of freedom	Average squares	F	Probability	Critical value for F
Among groups	141.066667	1	141.066667	83.6021798	7.6962E-13	7.0930973
Within groups	97.8666667	58	1.68735632			

In summary, the ANOVA method presents the F value of 83.6, which is greater than the critical values with significance levels of 0.05, 0.025 and 0.01. Therefore, the alternative hypothesis is accepted:
• Alternative hypothesis (Ha): The design of audiovisual contents via infographics in SHAU 2.0 facilitates the process of teaching and learning on Boolean algebra

7. DISCUSSION

Teachers need to analyze the technological, scientific and educational in order to design new virtual spaces that enhance the teaching - learning strategies. The infographic is an alternative that should be considered because it allows communicate information of the subjects in a simple and understandable way for students.

This research highlights the importance of the use of infographics in the web systems considering the characteristics of users. In particular, audiovisual contents based on the styles of visual and auditory learning facilitates the educational process.

The SHAU 2.0 promotes the use of infographics as a strategy for the transmission of audiovisual contents related to Boolean algebra considering the level of knowledge and profile of students.

The Quantitative Approach enabled this research to analyze student achievement before (pre-test) and after (post-test) using the SHAU 2.0. Through the ANOVA method states that the design of audiovisual contents based on infographics enhances the educational process connected with Boolean algebra.

Importantly, the combination formed by the use of infographics and technology facilitates the compression of information, promotes the development of critical thinking and improves retention of ideas and concepts.

Finally, it is necessary that universities promote training courses on instructional design, information and skills in order to create new custom virtual environments that foster meaningful learning.

8. REFERENCES

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