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INVESTIGACIÓN / RESEARCH

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## USABLE WEB INTERFACE: TECHNOLOGICAL TOOL FOR TEACHING-LEARNING

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### ABSTRACT:

Technological advances are leading to significant changes in the way of planning and organizing activities in educational institutions. Teachers are becoming the key element in the transformation of virtual environments for teaching and learning. Currently, students taking the subject of Algorithms and programming principles in a university located south of Mexico City, Mexico have difficulty understanding the concepts related control structures and programming language C. For this reason, the teacher charge of this matter decided improve Usable Web Interface (IWU) via accessibility giving rise to IWU 2.0 aimed at providing users with diverse audiovisual content in Spanish and English languages, which are appropriate to their characteristics and needs. The design of the IWU 2.0 employs the principles of accessibility called Web Contents Accessibility Guidelines (*WCAG 2*) related to the use of perceptible, operable, understandable and robust information. This research is based on the quantitative approach through T test with significance level of 0.1 and 0.05 to analyze the behavior of 18 students through the application of two questionnaires related to Control Structures: pretest (unused technology) and posttest where IWU 2.0 is used as a teaching support during the classroom course.

**KEY WORDS:** Higher Education - Information Technology - Web Interface - Accessibility of audiovisual content.

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# **INTERFAZ WEB USABLE: HERRAMIENTA TECNOLÓGICA PARA EL PROCESO DE ENSEÑANZA-APRENDIZAJE**

## **RESUMEN:**

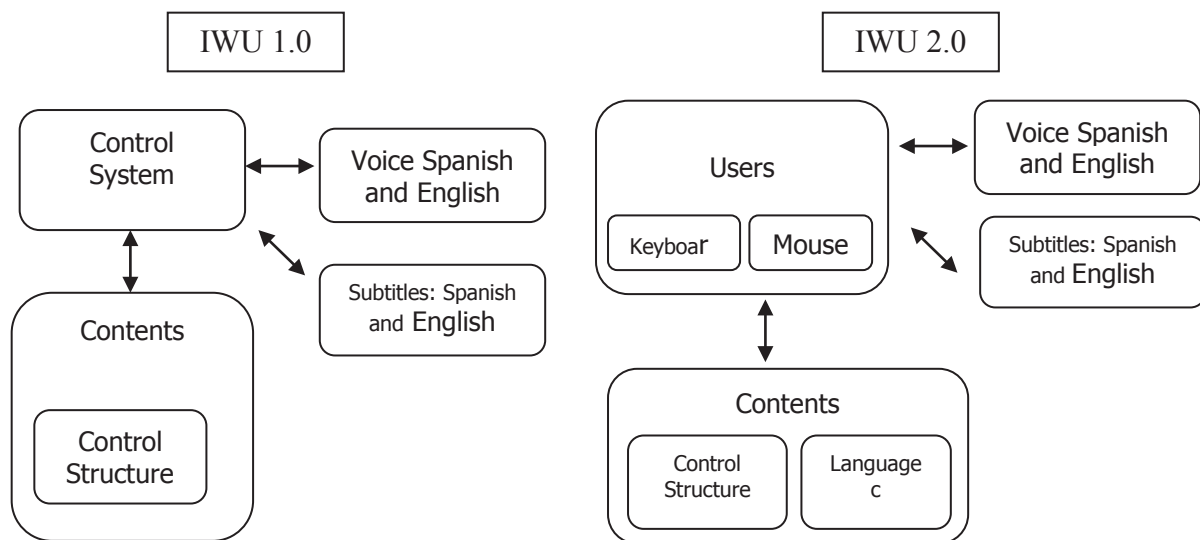
Los avances tecnológicos están propiciando cambios significativos en la forma de planear y organizar las actividades en las instituciones educativas. Los docentes se están convirtiendo en el elemento clave durante la transformación de los entornos virtuales de enseñanza-aprendizaje. Actualmente, los estudiantes que cursan la asignatura de Algorítmica y principios de programación en una universidad ubicada al sur del Distrito Federal, México presentan dificultades para entender los conceptos relacionados con las Estructuras de control y el Lenguaje de programación C. Por esta razón, el docente encargado de esta materia decidió mejorar la Interfaz Web Usable (IWU) por medio de la accesibilidad dando origen al IWU 2.0 cuya finalidad es brindar a los usuarios diversos contenidos audiovisuales en los idiomas español e inglés, los cuales se adecuan a sus características y necesidades. El diseño de la IWU 2.0 emplea los principios de la accesibilidad denominados Web Contents Accessibility Guidelines (*WCAG 2*) relacionados con el uso de la información perceptible, operable, comprensible y robusta. Esta investigación se apoya en el Enfoque cuantitativo por medio de la Prueba T con el nivel de significancia de 0.1 y 0.05 para analizar el comportamiento de 18 estudiantes a través de la aplicación de 2 cuestionarios relacionados con las Estructuras de control: preprueba (sin uso de la tecnología) y postprueba donde se utiliza la IWU 2.0 como apoyo didáctico durante el curso presencial.

**PALABRAS CLAVE:** Educación Superior - Tecnología de la información - Interfaz Web – Accesibilidad de los contenidos audiovisuales

## **1. INTRODUCTION**

In Mexico, several universities are focused on academic training based on skills development and are beginning to consider strategic planning segment composed of adult persons that combine educational activities with the business, which has led to the creation of executive degrees. In this new model of teaching and learning, the vast majority of pupils have left school for more than eight years which has led academic obstacles exist during re-entry to the educational context. For this reason, higher education institutions have decided to train teachers through various courses related to the development of skills, the use of cutting edge technology and the use of instructional design.

In particular, the teacher in charge of the course: "Algorithms and programming principles". Usable Web Interface Design (IWU) in 2013 with the purpose of facilitating the process of educational related control structures. Over time, the teacher has noticed that the IWU version 1.0 needs to be updated in the aspects related to the design of the web interface and audiovisual content considering the criteria of accessibility. It is noteworthy that the IWU version 2.0 has the public register of copyright No: 03-2014-112809320900-01. Figure 1 presents version 1.0 and 2.0 of the IWU.



**Graphic 1: IWU version 1.0 and 2.0.**  
*Source: Own design 2014*

As shown in Figure 1, the IWU 2.0 allows the user to configure the related audiovisual content with control structures and programming language C according to their needs (accessibility).

According to Shirogane, Mori, Iwata and Fukazawa (2008), accessibility means that people can use information technology to meet their needs through the recommendations Web Contents Accessibility Guidelines (WCAG). Furthermore, these authors emphasize the importance of using the keyboard, aesthetics (the use of color and font properties) and Support for easy navigation and transmission of information on the web alternatives.

In short, the teacher in charge of the course "Algorithms and programming principles" want to analyze the behaviors of students (knowledge) on Control Structures and C Programming Language by using the IWU 2.0.

## **2. OBJECTIVES**

This research related to the use of cutting edge technology (IWU 2.0) in the teaching-learning process has the following objectives:

1. Design the IWU 2.0 considering the aspect of accessibility of audiovisual content
  2. Build audiovisual content on Control Structures considering its relationship with the programming language C
  3. Use the IWU 2.0 for the course "Algorithms and programming principles" during the 2014-3 cycle
  4. Analyze the impact of using the IWU 2.0 during the teaching-learning process
- The methodology used for this research project is described.

## **3. METHODOLOGY**

This research is supported by the Quantitative Approach in order to analyze the behavior of students before and after using the IWU 2.0 on the subject of Algorithms and programming principles. According to Giroux and Tremblay (2004), this approach allows to analyze the phenomena through measurement and analysis figures.

The overall objective of this research is:

Design and implement audiovisual content of the IWU 2.0 through accessibility to facilitate the teaching-learning Control Structures

The sample consists of 18 students studying Executive Bachelor in computer systems during the 2014-3 school year at a university in the south of Mexico City, Mexico.

According Elizondo (2002), the experimental method is based on deliberate production of phenomena to analyze their characteristics. The independent variable refers to the IWU 2.0 built based on the availability of audiovisual content and the dependent variable consists of the development of knowledge related to structures of control.

The research is based on the following assumptions:

Null Hypothesis (Ho): Students using the IWU 2.0 do not show an improvement in the level of achievement (knowledge) on control structures and programming language C.

Alternative hypothesis (Ha): Students using the IWU 2.0 presented an improvement in the level of achievement (knowledge) on control structures and programming language C.

In the case of this research, diagnosis questionnaire on control structures and programming language C (pretest) and a questionnaire were used to analyze the behavior of students after using the IWU 2.0 during the teaching-learning process (posttest). It is noteworthy that the T test allows this research analyzed with a significance level of 0.05 and 0.1 data collected from the questionnaires.

The item related to the accessibility of audiovisual content used during the construction of the IWU 2.0 describes.

### **3.1 Accessibility**

Today, universities in Mexico looking to integrate new teaching, research and technology that enable innovative plan and implement virtual environments that facilitate the efficient development of skills in students' methods. For this reason, teachers analyze the progress that presents cutting-edge technologies for the design and construction of the systems on the network. In particular, the availability of audiovisual content offers an alternative to create websites that are tailored to the characteristics of users.

According to Moreno, Martinez and Ruiz (2009) criteria of accessibility of audiovisual content on the web (WCAG 2.0) are closely related to usability, which facilitates the process of teaching and learning, web browsing and provides useful for the user by means of the following information:

1. Visibility of system status in
2. Flexibility and efficiency of use
3. Using everyday language
4. Ability to recognize the functions in the system
5. Control System User
6. Preventing Errors
7. Use of standards and consistency in design
8. Provide user support during navigation

According to Allsopp (2009), the standards of accessibility of audiovisual content (WCAG 2.0) allow to adapt efficiently advances in web technology through the application of the 4 principles: perceivable, operable, understandable and robust. Griol, Callejas and Lopez (2013) explain the four principles of accessibility of audiovisual content:

1. Perceptible: information and interface components must be presented to users in various forms
  2. Operable: the elements of the interface must be simple
  3. Understandable: the contents and operations of the interface must be understandable for users
  4. Robust: The content and interface to be used by as many people as possible
- The following describes the aspects related to the accessibility of audiovisual content used during the construction and implementation of the IWU 2.0.

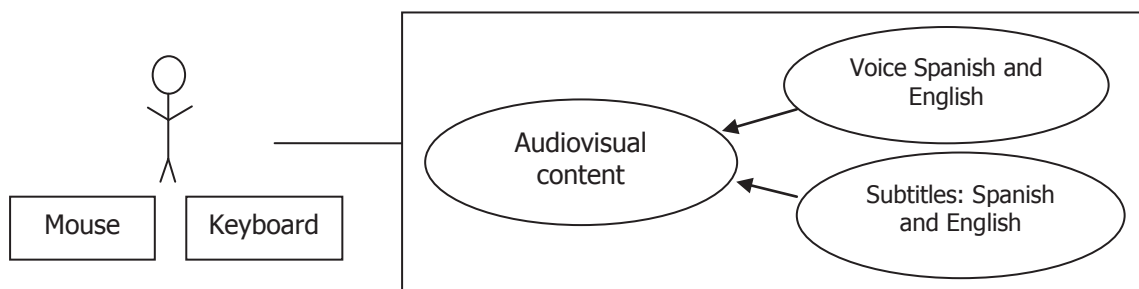
#### 4. DISCUSSION

The IWU 2.0 designed for this research used as one of the innovators of the accessibility of audiovisual content aspects. As mentioned Moreno (2008, p.93), "Web Accessibility refers to the ability to access a Web site for all users, regardless of disability or context navigation, so that users will be able to perceive, understand, navigate and interact with the site. "

In particular, the development and planning information on Control Structures and C Programming language used called WCAG 2.0 standards created by the World Wide Web Consortium (W3C) related aspects: perceivable, operable, understandable and robust.

##### 4.1 Using the perceptible principle in the IWU 2.0

The first principle of accessibility audiovisual content provides that information and interface elements should be presented in ways that users can distinguish them. Guideline 1.1 states that you must provide text alternatives. The design of the IWU 2.0 allows students to control the subtitles during the execution of interactive material on Control Structures via mouse and keyboard. Figure 2 shows a diagram used to construct the IWU 2.0.



**Graphic 2:** Employment Guideline 1.1 on accessibility in the IWU 2.0  
 Source: Own design 2014

Guideline 1.2 on accessibility states that you must provide alternatives for audiovisual content over time. In particular, the IWU 2.0 allows the user to configure the Web interface through voice and subtitles during execution. (See Figure 3).

# Sequence



- Instruction 1
- Instruction 2
- Instruction 3

**Control structure (sequence)**

# Sequence

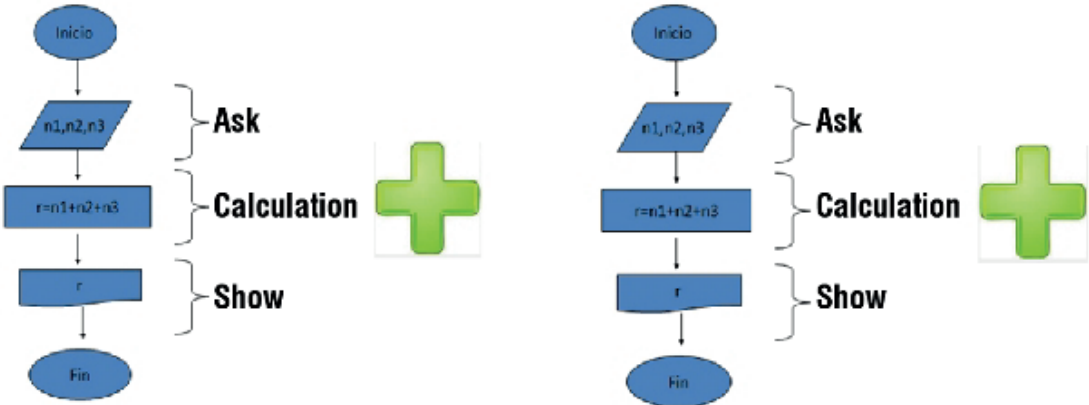


- Instruction 1
- Instruction 2
- Instruction 3

**Control structure (sequence)**

*Graphic 3: Employment Guideline 1.2 on accessibility in the IWU 2.0  
Source: Own design 2014*

Guideline 1.3 states that the audiovisual content should be presented in various ways without losing information. Therefore, the user can set the educational platform to observe only the transcription of the information or listen to the video dialog maintaining the same structure (see Figure 4).



The flowchart is graphical representation of the algorithm. In this case the sum of the three numbers displayed.

*Graphic 4: Employment Guideline 1.3 on accessibility in the IWU 2.0  
Source: Own design 2014*

Finally, Guideline 1.4 states that you must provide users see and hear the data. In this sense, the IWU 2.0 presents the help section and allows the user to configure the topics Control Structures via mouse or keyboard.

Figure 5 shows the help section where the actions that can be performed on the IWU 2.0 via the keyboard (shortcut) or mouse are described.

CONFIGURATION	
Voice:	Spanish Man
Subtitle:	Spanish
Control:	Voice
Access:	Date

*Graphic 5: Employment Guideline 1.4 on accessibility in the IWU 2.0  
Source: Own design 2014*

#### 4.2 Use of operable principle in the IWU 2.0

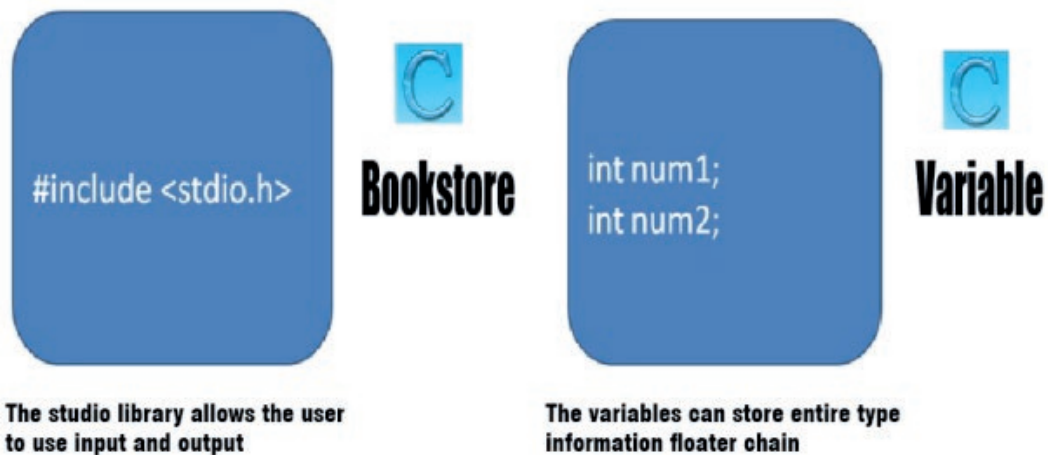
According to Moreno (2008), the second principle of accessibility requires that the components of the interface and navigation simple duty, ie, 2.1 Guideline states that the keyboard is used for interaction between user and information. In particular, the college student can change settings and control the multimedia product IWU web 2.0 via the keyboard. Figure 6 depicts the shortcut used in this research.

Key: i Start the audiovisual content	Key: Right Arrow Forward audiovisual content	Key: a Increase sound
Key: p Stop the audiovisual content	Key: Left Arrow Back audiovisual content	Key: d Decrease sound
Key: Down Arrow Change subtitles	Key: Up Arrow Change voice	

*Graphic 6: Employment Guideline 2.2 on accessibility in the IWU 2.0  
Source: Own design 2014*

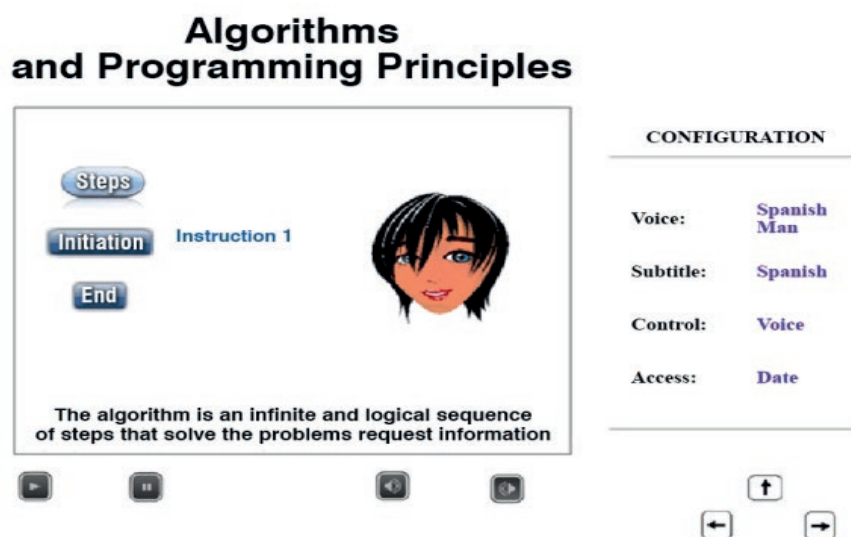


Finally, Guideline 2.3 states that you must not design content in ways that are known that can cause seizures and Guideline 2.4 mentions that should provide ways to help users navigate and determine where they are. Figure 8 shows the IWU 2.0.



*Graphic 7: Employment Guideline 2.2 on accessibility in the IWU 2.0  
Source: Own design 2014*

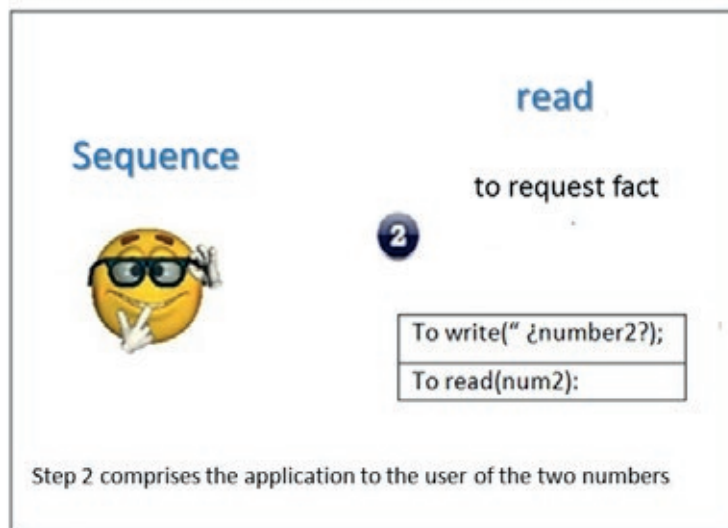
Finally, Guideline 2.3 states that you must not design content in ways that are known that can cause seizures and Guideline 2.4 mentions that should provide ways to help users navigate and determine where they are. Figure 8 shows the IWU 2.0.



*Graphic 8: Using Guideline 2.3 and 2.4 on accessibility in IWU 2.0  
Source: Own design 2014*

### 4.3 Using the understandable principle in the IWU 2.0

The third principle on the accessibility of audiovisual content refers to the information and management interface must be clear. In particular, Guideline 3.1 states that the textual content must be legible and understandable. For this reason, planning and implementation of the IWU 2.0 relies on the proper selection of the graphic identity in order to achieve meaningful student learning (see Figure 9).



*Graphic 9: Employment Guideline 3.1 on accessibility in the IWU 2.0  
Source: Own design 2014*

The proper selection of color, size and style of font and images allow creating suitable for message transmission virtual scenarios. According to Alberich (2007) is fundamental to establishing a uniform graphical code (graphics and images elements), typographic code (font family, hierarchies, margins) and color code (palettes).

During the design of the IWU 2.0 is considered the font family, hierarchies and margins for the construction of the Web interface.

In addition Gallego (1999) explains that the 20% rule is to categorize the use of sizes and thicknesses. Sklar (2009) explains that to create an effective design will need to select a few styles and font sizes, using available sources and design using readability. Therefore, the letters used in the design of the IWU 2.0 contents belong to the family of fonts "sans-serif".

Another factor to consider when designing the compressible audiovisual content is

the color code. According to Sharpless (2006), color is one of the most important visual elements for design because it will guide you to a specific location within the interface and allows for differences between the elements (see Table 1).

She differs among the elements (to See Table 1).

**Table 1**  
*Psychology of Color*

Using color					
Red	Blue	Green	Crey	White	Black
power	peace	nature	intelligence	pure	wealth
energy	accuracy	Health	modesty	quiet	formality
passion	calm	Good	Maturity	innocence	Anger
		Luck			
love	harmony	Environment	future	Death	power

Tomado de Sharpless, 2006.

According to Fernández (1998), the use of different colors confuses the user, who will not know what place to look closely. That is, it is convenient to define three or four basic colors and use their combinations of tone. Consequently, planning IWU 2.0 uses three basic colors: white, black and blue Figure 10 shows the use of the graphic, typographic and color codes in IWU 2.0.

## Algorithms and programming principles

The image shows a user interface for 'Algorithms and programming principles'. It features a 'Sequence' step with a yellow emoji wearing glasses and a 'Read' step with a blue circle containing 'E'. Below the 'Read' step is a code box with the text 'suma=num1+num2;'. At the bottom of the main content area, it says 'Step 3 takes the sum of the two numbers.' To the right is a 'CONFIGURATION' panel with the following settings: 'Voice: Spanish Man', 'Subtitle: Spanish', 'Control:', and 'Access:'.

**Graphic 10:** Using the graphic, typographic and color code on the IWU 2.0  
Source: Own design 2014

Similarly, Guideline 3.2 on understandable audiovisual contents states that Web pages must be controlled in a predictable way. Consequently, the construction of the multimedia interactive product uses easy-to-recognize images such as play and stop icons or arrows.

#### 4.4 Uso del principio robusto en la IWU 2.0

This principle on accessibility of audiovisual contents means that information must be interpreted by a wide range of individuals. Particularly, Guideline 4.1 states that compatibility with the agents of current and future users, including support products, must be maximized. Therefore, the design of IWU 2.0 uses HTML 5 language as a novel element to convey knowledge to as many users as possible.

As Meyer mentions (2010), this language has new features facilitating the way of transmitting information on the Internet. For example, <video> transmits audiovisual contents in different browsers like Internet Explorer, Firefox, Opera, Chrome and Safari through ogg, mp4 and webm formats. It also supports access to information on the Web through different operating systems like Linux, Mac and Windows.

JavaScript allows control of the activities of the Website through programming. Particularly, this program allows you to create buttons to manage video, animations and sound according to the needs of students Accordingly, the arrangement of IWU 2.0 relies on technological breakthroughs related to HTML 5 and JavaScript to create a scenario conducive to meaningful learning in students.

#### 4.5 Results

Through the spreadsheet, T Test is performed with the significance level of 0.05 and 0.1. Table 2 shows that the mean pretest is 5.38 and the mean posttest is 8.22.

**Table 2**

T test with significance level of 0.05

	pretest	posttest
Average	5.38888889	8.22222222
Variance	4.36928105	1.12418301
Comments	18	18
Pooled Variance	2.74673203	
Hypothetical mean difference	0	
Degrees of freedom	34	
Statistical t	5.12874114	
P(T<=t) Two Tails	1.1694E-05	
Critical value of t (two-tailed 9)	2.0322445	

*Source: Own design 2014*

As shown in Table 2, the null hypothesis is rejected because the critical value for two-tailed t (2.03) is greater than the statistical value. Therefore, one can conclude that IWU 2.0 improves the level of achievement of students who study control structures and programming language C.

Table 3 shows the results of T test with the significance level of 0.1, where the null hypothesis is rejected once again and the alternative hypothesis is accepted.

**Table 3**

T test with significance level of 0.1

		pretest	posttest	Own
devising,	Average	5.38888889	8.22222222	2014
	variance	4.36928105	1.12418301	
In summary, with	comments	18	18	T test
	pooled Variance	2.74673203		
	Hypothetical mean difference	0		
	Degrees of freedom	34		
	statistical t	-.12874114		
	P(T<=t) Two Tails	1.1694E-05		
	Critical value of t (two-tailed 9)	1.6909242		

significance levels of 0.1 and 0.05 allows us to affirm that using IWU 2.0 improves the level of achievement in students as regards the contents of control structures and programming language C.

## 5. CONCLUSIONS

Teachers and educational institutions need to propose new alternative technologies facilitating the teaching-learning process for students to efficiently develop their skills. Particularly, IWU 2.0 is an educational web interface that allows the user to control how to present audiovisual contents on Control Structures and Programming Language C by selecting the voice and text alternatives.

It is important that students have the support of various didactic resources associated with cutting edge technology to enable them to understand and apply knowledge of the subjects in the contexts attached to reality. In the case of this piece of research, IWU 2.0 allowed the students studying algorithms and programming principles to improve their good use (knowledge) as they can customize information according to their characteristics.

Accessibility of audiovisual contents is an element that must be considered when designing and implementing systems because it facilitates transmission of perceivable, operable, understandable and robust data. For example, the use of text alternatives helps visual learners understand the contents, the keyboard allows users to control the web interface in a fast, simple and intuitive way, and aesthetics facilitates dissemination of the educational message.

Also, design of the web interface considering HTML5 language is recommended because that can offer the user flexibility in browsers and operating systems.

Finally, teachers must be constantly training in order to improve their knowledge and skills concerning the use of technology in education so as to be able to create innovative virtual spaces that enhance the teaching-learning process. For example, IWU 2.0 gives students the opportunity to receive information on control structures and programming language C considering their features.

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