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REFLECTION ARTICLE

Theoretical and conceptual principles for making Universal Access to Knowledge in Mexico

Principios teóricos y conceptuales para realizar Acceso Universal al Conocimiento en México

Princípios teóricos e conceptuais para tornar o Acesso Universal ao Conhecimento no México

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Abstract

Introduction: Universal Access to Knowledge (AUC) is a recently promoted term by the National Council of Humanities, Sciences and Technologies (CONAHCYT) of Mexico, but there is no clear guide to realise it. Therefore, there is a need for an AUC model with best practices for the expansion of science in society. **Objective:** to present in a clear and concrete way a set of theoretical, conceptual and procedural principles that are useful to carry out AUC in the Mexican context. To this end, it is necessary to describe that scientific communication is divided into two main categories: dissemination, which presents findings from the scientific field among specialists, and popularisation, which shares science with the general public. The AUC is an emerging science outreach strategy that is governed by principles of open access and horizontal communication to promote interest in science among all people. **Reflection:** In such a way that, this proposal is headed by the mentioned concepts and the fundamentals of graphic and audiovisual design are added to better face the challenge of making AUC. This open and horizontal approach to communicate science to the non-specialist public will be useful to define what Universal Access to Knowledge is and how to carry it out, as well as to consolidate the scientific community as a key part of society and to boost the interest of children and young people in scientific research.

Keywords: Open Access; Universal Access to Knowledge; Knowledge Dissemination; Scientific Dissemination.

Resumen

Introducción: El Acceso Universal al Conocimiento (AUC) es un término de reciente impulso por parte del Consejo Nacional de Humanidades, Ciencias y Tecnologías (CONAHCYT) de México, pero no hay una guía clara para realizarlo. Por lo anterior, es necesario un modelo de AUC con las mejores prácticas para la expansión de la ciencia entre la sociedad. **Objetivo:** exponer de manera clara y concreta, un conjunto de principios teóricos, conceptuales y procedimentales que sean útiles para realizar AUC en el contexto mexicano. Para ello, es preciso describir que la comunicación científica se divide en dos categorías principales: la difusión, que expone hallazgos del campo científico entre especialistas, y la divulgación, que comparte la ciencia con el público general. El AUC por su parte, es una estrategia emergente de divulgación científica que se rige bajo principios de acceso abierto y comunicación horizontal para promover entre todas las personas, el interés por la ciencia. **Reflexión:** De tal forma que, esta propuesta está encabezada por los conceptos mencionados y se añaden fundamentos del diseño gráfico y audiovisual, para enfrentar de una mejor manera el reto de realizar AUC. Este enfoque abierto y horizontal para comunicar la ciencia al público no especializado, será útil para definir qué es y cómo realizar Acceso Universal al Conocimiento; así como también, consolidar a la comunidad científica como pieza clave de la sociedad e impulsar el interés en niñas, niños y jóvenes por la investigación científica.

Palabras clave: Acceso abierto; Acceso Universal al Conocimiento; Difusión de conocimientos; Divulgación científica[1]

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1 Los términos clave han sido recuperados a partir del Tesauro UNESCO (Ciencias Sociales y Humanidades)

Resumo

Introdução: O Acesso Universal ao Conhecimento (AUC) é um termo recentemente promovido pelo Conselho Nacional de Humanidades, Ciências e Tecnologias (CONAHCYT) do México, mas não existe um guia claro para o concretizar. Por conseguinte, é necessário um modelo de CUA com as melhores práticas para a expansão da ciência na sociedade. Objetivo: apresentar de forma clara e concreta um conjunto de princípios teóricos, conceptuais e processuais que sejam úteis para realizar as CUA no contexto mexicano. Para tal, é necessário descrever que a comunicação científica se divide em duas categorias principais: a divulgação, que apresenta os resultados do campo científico aos especialistas, e a popularização, que partilha a ciência com o público em geral. O AUC é uma estratégia emergente de divulgação científica que se rege por princípios de acesso aberto e comunicação horizontal para promover o interesse pela ciência entre todas as pessoas. Reflexão: De tal forma que, esta proposta é encabeçada pelos conceitos mencionados e os fundamentos do design gráfico e audiovisual são adicionados para melhor enfrentar o desafio de fazer o AUC. Esta abordagem aberta e horizontal para comunicar a ciência ao público não especializado será útil para definir o que é o Acesso Universal ao Conhecimento e como realizá-lo, bem como para consolidar a comunidade científica como uma parte fundamental da sociedade e para impulsionar o interesse das crianças e dos jovens pela investigação científica.

Palavras-chave: Acesso Aberto; Acesso Universal ao Conhecimento; Difusão do Conhecimento; Divulgação Científica.

INTRODUCTION

Universal Access to Knowledge (AUC) is a term recently promoted by the National Council of Humanities, Sciences and Technologies (CONHACYT) in Mexico, as an open science policy for Mexican society to exercise its right to enjoy the benefits of scientific and technological progress (CONAHCYT, 2023). Similarly, the AUC is one of the main requirements to be integrated, maintained or promoted within the science and technology research programs supported by CONAHCYT. This has caused confusion among the scientific community because there is not yet a clear and complete guide to carry it out. Therefore, it is necessary to propose an AUC model that includes theoretical and conceptual principles that guarantee the expansion of scientific and technological knowledge among the general public, in order to eliminate uncertainty and recognize AUC as a key element in State policies in favor of the population.

The present work exposes at first, the differences between scientific dissemination, scientific popularization and AUC, to provide a useful context towards the understanding of horizontal dialogue, a basic component of the interaction between the scientific community and the general public, with which the recognition of knowledge is promoted (Universidad Autónoma Metropolitana & Comunicación del conocimiento, 2023). In the same way, the fundamentals of graphic and audiovisual design have a fundamental place in this proposal, because they guarantee a significant impact in the exhibition of scientific knowledge shared through the AUC.

Finally, this article is also important because it encourages reflection on the ways in which science popularization is done in Mexico and its impact on society. Likewise, to carry out AUC through the theoretical and conceptual principles included in this work will be useful for the non-specialized public to understand the relationship between their daily life and scientific research. Also, to promote in children and young people, the interest in the scientific profession and its place as a fundamental part of Mexican society.

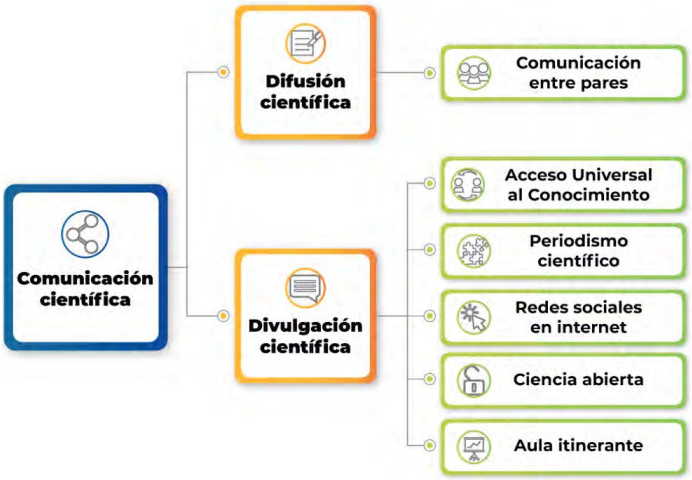
2. THEORETICAL FRAMEWORK

In order to better describe the theoretical and conceptual principles for conducting AUC in Mexico, it is necessary to mention that AUC is a strategy of scientific dissemination and that it, like scientific dissemination, belongs to a larger category: science communication (see Figure 1).

Scientific dissemination is defined as the exposure of scientific knowledge among peers, i.e., from specialists to specialists. In this case, science dissemination drives the interaction between experts in science and the creation of new work teams in which they discuss through formal reasons and arguments (Ramírez et al., 2016).

In this way, scientific dissemination is a fluid process because, from a communicational point of view, the codes used in dissemination do not require any transformation, so that the interaction between actors is strengthened with each new dissemination action. In this case, we speak of horizontal communication.

Figure 1
Scientific communication



Note: Own elaboration based on Bernardino et al., (2018), Universidad Autónoma Metropolitana & Comunicación del conocimiento (2023), Garza-Almanza (2016), Morandeira et al. (2019) and Tenorio et al. (2019).

For its part, science popularization is made up of a set of activities by which scientific knowledge is made available to the non-specialist population and requires a reformulation of the scientific discourse in which both the general public and the scientific community contribute (Morgado and Fernández-Silva, 2020). The above, in order to broaden the scope of science and thus fulfill the commitment by which all sectors of society receive the benefits of advances in science.

The following are five of the most relevant science outreach strategies:

- Universal Access to Knowledge. Sharing scientific knowledge with the general public through horizontal dialogues (Universidad Autónoma Metropolitana & Comunicación del conocimiento, 2023).
- Science journalism. Exposing science to the public, in a newsworthy way (Garza-Almanza, 2016).
- Social networks on the Internet. Facilitate interaction between the scientific community and the general public, as a result of the constant growth in the number of internet users (Morandeira et al., 2019).
- Open science. Unrestricted access to scientific information (Tenorio et al., 2019).
- Itinerant classroom. Bringing science to the public, to promote scientific vocation and culture (Bernardino et al., 2018).

Accordingly, science outreach faces the challenge of building the necessary links to complete the communication cycle through adjustments in language, leveraging

of available means and other actions aimed at eliminating or at least reducing the gap between experts and non-experts.

On the other hand, the AUC, as an emerging strategy of scientific dissemination promoted by CONAHCYT, is a way of sharing science through actions close to the general public. In this same line, the Direction of Universal Access to Knowledge (DAUC) of CONAHCYT, indicates that it should generate links that promote mutual recognition among the different knowledge, of which the biocultural wealth of Mexico is constituted (CONAHCYT, 2023). In other words, the AUC, in terms of CONAHCYT, plays a role as a social instrument that promotes equity among the different sectors that make up Mexican society.

Similarly, the DAUC also indicates that the AUC should be executed through the following axes (Universidad Autónoma Metropolitana & Comunicación del conocimiento, 2023):

- Linkage between AUC communities.
- Common objectives, epistemic soundness.
- Linkage with local and regional communities.
- Exchange of knowledge and resources.
- Generation of synergies in networks.
- Addressing strategic issues.
- Integration of art as a tool for dialogue.

3. REFLECTION

Historically, there has been a gap between the scientific community and the general public, fed in large part by the idea that scientific work is insensitive to what happens within social groups, especially the most disadvantaged. Thus, the scientific community still has a long way to go to consolidate itself in the collective imagination. Because, although it is true that one of the purposes of scientific dissemination is to show society that science advances in favor of all people, in most cases, it has been carried out through a vertical dialogue. In which the scientific source produces messages without previously considering the context and knowledge of the target audience, which are the most relevant media according to the case and how much impact specialized knowledge has on the general public.

In view of the above, there is a critical current that proposes the use of horizontal dialogue in the popularization of science, among other things, to eradicate this misperception about scientific work and its actors, as well as its methods and products. Horizontal interaction promotes the use of official and scientific procedures in which the prior opinion and acceptance by the

public in general, whenever it is involved or altered in any way (Briones, 2020).

In the same vein, horizontality is based on equity and is composed of those who participate in the production and extension of knowledge, as well as those who receive and benefit from it. Thus, horizontal methods define research and production of scientific knowledge as an agreement that originates forms of better coexistence in the public space (Corona & Kaltmeier, 2012). In this way, a new way of doing science is generated, in which those who emit and those who receive, converse in turn and contribute with their perceptions, to establish solutions to problems that affect society as a whole (Corona, 2020).

This horizontality must be present in a meaningful way in an open and broad scientific communication model for the AUC. It employs a sensitive dialogue with respect to the history and context of the target audience. Such sensitivity is also present when including, without restriction, groups in vulnerable situations that have been historically ignored, such as indigenous communities, communities of sexual diversity and people with disabilities, among others.

In this sense, the AUC is also an initiative in favor of building links between specialized knowledge and society in general, through gradual approaches and previous talks that aim to raise public awareness about the benefits of scientific progress and its products. These approaches are also made so that science specialists can register agreements and present them as evidence when participating in calls for proposals to support scientific research, such as those of CONAHCYT. Similarly, quality and innovation in AUC projects can be guaranteed by incorporating specialists in graphic and audiovisual communication for the production of outreach materials such as illustrations, videos, animations and audios, among others (Universidad Autónoma Metropolitana & Comunicación del conocimiento, 2023).

Accordingly, graduate students who have received a CONAHCYT scholarship can take advantage of the principles of the AUC to carry out social retribution activities by sharing their knowledge with the general public within the framework of horizontal communication. Some examples of the above may be:

- Talks in an elementary school in which the age and context of the students are considered.
- Presentations to an indigenous community in which terms and forms of native cultures are used.
- Information sessions aimed at a group of women victims of violence in which their emotional condition is taken into account.
- Teaching activities in a special education institution where the concept of universal access is given priority.

On the other hand, the Open Science movement is a very important reference for the AUC. Because it establishes, among other things, that "scientific knowledge in all its forms must be openly accessible, transparent, rigorous, reproducible, replicable, cumulative and inclusive" (Meier et al., 2022). In this sense, a model of scientific dissemination for the AUC should also include the following mechanisms

necessary to ensure permanent and unconditional access to scientific research.

Open Science also implies a set of philosophies and practices that aim to make scientific research clearer, more accessible and accountable. This is made possible through open access to scientific publications, data sharing and open source software development. As a result, collaboration is fostered, research is streamlined and the free exchange of knowledge is facilitated (Jeremy et al., 2024).

Another benefit of applying Open Science principles in AUC is that, by making scientific processes transparent, it increases the number of people who verify methods, analyses and results of scientific research to confirm findings. It thus contributes to the advancement of knowledge in a given area (Tamminen & Pucher, 2018).

The inclusive approach of Open Science and the growth of its acceptance in the world are very favorable factors for the expansion of scientific research in society. Therefore, it is very important to consider it as a fundamental reference in AUC strategies.

Similarly, the concept of Citizen Science is present in the AUC, through the principle of universality proposed by Robert Merton in 1938, which describes that the origin and condition of a person does not exclude him/her from the scientific process. So, all people can actively participate with their questions, observations and opinions, which are later included as part of a scientific study (Scheibein et al., 2022). Thus, Citizen Science promotes the "democratization" of science, which implies that the entire population has the possibility of appropriating scientific knowledge. Thus, the AUC guarantees open access to science, through actions in which the general public actively participates.

On the other hand, and in order to better understand how AUC is carried out, it is necessary to reflect on the fact that scientific dissemination is a communication exercise and, in the case of AUC, it is broad, open and horizontal. It is broad because it uses the available means to make specialized knowledge available to the general public; open, because there are no restrictions on access to information; and horizontal, because it takes into account the prior knowledge of the disseminator and the learner. Therefore, AUC objects require a series of steps in their elaboration to guarantee their function as teaching resources.

The following are five examples of AUC products and their basic processing components:

Disclosure article

It is a digital file containing a combination of text and images (photographs, illustrations, tables, figures, etc.), in which the subject is presented in a clear, simple and general way. The basic structure of a scientific report is respected in terms of an introduction, an explanation of the actions carried out, an explanation of the most relevant results and a conclusion on what was observed. In keeping with the sense of horizontality that is a fundamental part of the AUC, the information is presented in a short and simple narrative that takes into account the knowledge of the target audience.

Regarding the visual components, the typeface used should be easy to read. The best-known fonts such as *Times New Roman, Georgia, Arial and Helvetica* are almost a standard in editorial design. Because it has been proven over time that they are ideal to favor the comprehension of

texts. The images used must be clear, so that there is no doubt as to their meaning and intention.

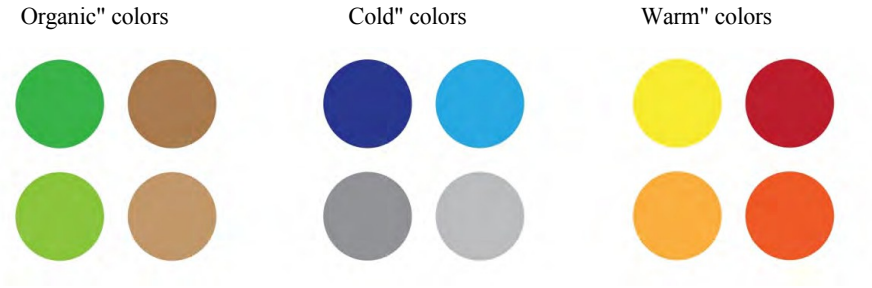
Infographics

It is an image file, with which it is possible to explain a specialized topic in a summarized way through illustrations and short texts. The following are four of the design fundamentals recommended in AUC infographics:

Color. It is a visual element that, because of its relationship to human emotions, can drive the learning of a subject. Combinations of colors similar to each other cause a sense of harmony. Contrasts, on the other hand, stimulate the attention of the observer (Wong, 2008). Organic" colors (those originally found in nature) are related to the natural sciences; "cold" colors (blue, gray and their variations) are related to the exact sciences; and finally, "warm" colors (yellow, red and their variations) are close to the social sciences (Figure 2). In the case of the graphic design for the AUC, a group of colors related to the exposed topic should be used to facilitate the understanding of the content.

Figure 2

Color

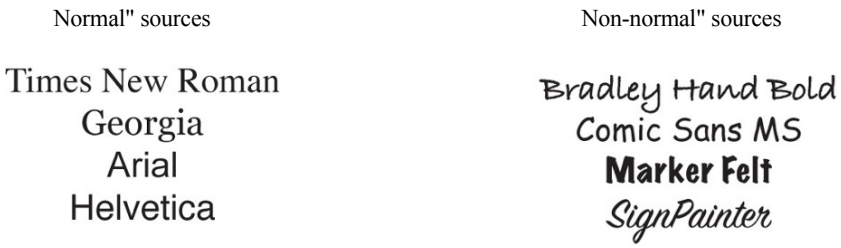


Note: Own elaboration based on Wong (2008).

Typographic design. The use of formal, usual and proven typefaces guarantees optimal readability and the use of too many different typefaces in a design should be avoided (Gómez, 2020). Thus, a disclosure object for the AUC does not have more than three different font styles in its main body. In this way, the attention of the learner is focused more on the content than on the medium (Figure 3).

Figure 3

Sources



Note: Own elaboration based on Gómez (2020).

Balance. The sensation of balance in a design is made possible by the sensitivity of those who observe and perceive unity in the arrangement of forms (Wong, 2008). It can be achieved by arranging visual elements with a sense of balance in the available space (Figure 4). Visual balance is applied in AUC with the main objective of constructing a clear and stable message, to foster meaningful learning.

Figure 4

The balance

Note: Own elaboration based on Wong (2011).

Structure. One of the key components to achieve the previous point, the structure is composed of invisible lines that define the position of the elements in a design (Wong, 2011). The dissemination design for AUC has order, which is guaranteed by the formal structures and is also part of the didactic sequences inherent to scientific dissemination (Figure 5).

Figure 5

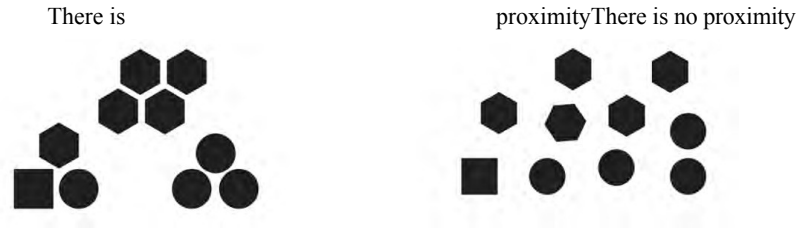
The structure

Note: Own elaboration based on Wong (2011).

Proximity. Principle by which shapes close to each other are perceptually grouped by the viewer (Forero et al., 2022), as can be seen in Figure 6. The design for the AUC applies the proximity principle to make evident the relationship between objects that are part of the same concept.

Figure 6

Proximity



Note: Own elaboration based on Wong (2011).

Video

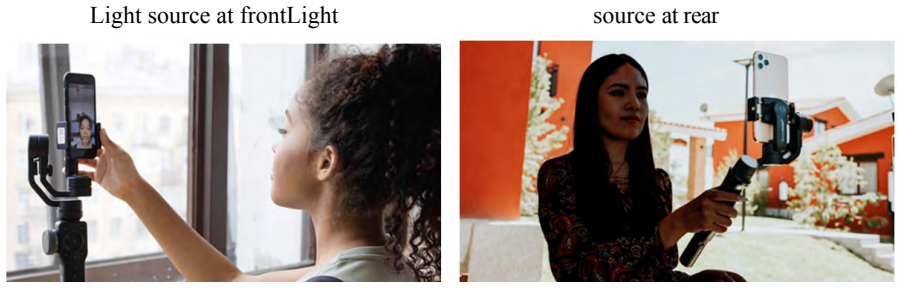
Video is one of the most flexible options for AUC's scientific dissemination, because it allows the combination of static images, animations, sounds and the appearance of the disseminator on screen. This modality also allows the use of one of the most recent teaching strategies, such as micro-learning. In this way, the understanding of topics is promoted through the delivery of small doses of content. These doses can be used more than once and act together with the purpose of producing knowledge in learners (Conopoima et al., 2021). Thus, the general public has the opportunity to appropriate scientific knowledge through a self-managed process.

Although ideally, professional video recording equipment should be used, researchers can produce their own AUC material using the webcam on their computer or mobile device. To do this, it is important to apply basic principles of audiovisual production, such as the following:

Lighting. The person on the screen should be positioned in front of the main light source, whether it is natural light or artificial light. Low illumination on the person may cause less attention to what is displayed (Figure 7). And finally, more light allows for more sharpness and better colors to be captured.

Figure 7

Lighting



Composition. If the person appears at the center of the screen, the empty spaces at the sides of his face should be equal. In this way, a sense of balance and visual harmony is produced, which favors learning. Another way to achieve a good composition in AUC videos is to place the person at the side of the screen, so that the free space is used for images related to the subject (Figure 8).

Figure 8

Lighting

Sound. Voice is best captured by a microphone placed close to the sound source. Lavalier" microphones are unobtrusive in video and can be clipped to clothing to provide freedom of movement (Figure 9). This ensures clear and simple video, characteristic of the AUC.

Figure 9

Lavalier" microphone

Podcast

It is a digital audio file that can also be published as short pieces. And, as part of an educational strategy of microlearning, it is also one of the easiest options to disseminate AUC. Likewise, the sound quality of the recording must be guaranteed. The best option is a condenser microphone; it is more sensitive and can capture better audio quality (Figure 10). With regard to the above, it is very important to assign a volume level to each sound source, depending on its importance within the exposition of the topic. In AUC Podcasts, ambient music or special effects have a lower volume than the voice of the speaker.

Figure 10

Condenser microphone

Face-to-face conference

It is a presentation in which the speaker coincides in the same place and time with the general public, the most usual examples being: a lecture in an auditorium, a talk in an educational center, an exhibition in a public space, and a conversation in a museum or library, among others. Some of the elements that reaffirm the face-to-face conference as an example of AUC are: face-to-face contact, spontaneous dialogue among participants and, above all, the opportunity to establish open and unrestricted communication (Figure 11). The personal presentation of specialists also promotes interest in science and a positive change in the perception of the scientific community among children and young people.

Documentation

The scientific dissemination of AUC, as one of the most important requirements for researchers who are part of CONAHCYT programs, must be documented in documents that record all interactions among participants. Such documents can be documents, applications, certificates of participation, photographs or videos in which the expansion of scientific knowledge among society in general is evident (Universidad Autónoma Metropolitana & Comunicación del conocimiento, 2023).

4. CONCLUSIONS

The AUC has been included among the most important requirements in CONAHCYT calls for proposals, such as the National System of Researchers (SNII), the National Strategic Education Program (PRONACES), Frontier Science and National Graduate Scholarships, among others, because it can become the most effective mechanism to make scientific knowledge available to the public, promote open access to scientific information and establish a dialogue in which the knowledge and opinions of all people without distinction are considered. In this sense, the application of basic principles of graphic and audiovisual design in AUC products guarantees the achievement of these goals, while at the same time providing a clear and concrete guide for the expansion of science to all sectors of society.

Likewise, the AUC model proposed in this work adds a humanistic approach to science communication by promoting a better perception of the scientific profession by the general public and, as a consequence, an increase in the number of children and young people who are interested in science, its advances, its products and, above all, its benefits.

Although the scientific literature on Universal Access to Knowledge is scarce today, this reflection exercise was possible thanks to the research in scientific articles on Horizontal Dialogue, Open Science, Scientific Dissemination and Fundamentals of Graphic and Audiovisual Design, among others. These concepts have been mentioned from within and outside CONHACYT when talking about AUC. In other words, the AUC concept is experiencing its first steps as part of scientific communication. It will continue to grow and take its place through the interaction between the scientific community and the general public. In a very special way, with the work of those of us who study, describe, design and publish it.

Conflicts of interest

The authors declare that there is no conflict of interest that could involve third parties in relation to this article for its publication.

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