

# ASTRO-TECH: La enseñanza de la astronomía desde el aprendizaje digital

## ASTRO-TECH: Teaching astronomy from digital learning

## ASTRO-TECH: Ensino de astronomia por meio da aprendizagem digital

 **Melkin Daniel Garzón Haad**

<https://orcid.org/0000-0002-5236-7571>

Universidad Sergio Arboleda

melkin.garzon01@usa.edu.co

Bogotá D.C., Colombia

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Layout and cover illustration  
Andrea Sarmiento Bohórquez

Style correction  
Nataly Marcela Muñoz Murcia



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## RESUMEN

La astronomía es una de las ciencias que ha estado involucrada en el desarrollo intelectual del hombre: ha dado explicaciones a los fenómenos que ocurren en el cielo y ha sido significativa en el desarrollo de las sociedades. Actualmente, goza de importancia en las investigaciones recientes sobre el espacio, y los nuevos hallazgos son tema de debate en la comunidad científica. Desafortunadamente, la astronomía se ha centrado en producir contenidos académicos y ha dejado de lado la divulgación al público. Las temáticas manejan un lenguaje muy técnico que abruma y produce confusión; además, son pocas las personas que se interesan en difundir sus contenidos y su margen de intervención es corto. No obstante, las nuevas plataformas digitales han promovido la transformación del conocimiento académico de las ciencias, adaptando la forma de enseñanza tradicional a una que involucre el aprendizaje autónomo de las personas. Por ello se propone realizar una cartilla digital que brinde un acercamiento a la astronomía desde un enfoque pedagógico y didáctico, traduciendo sus contenidos técnicos en un producto transmedia.

**Palabras clave:** astronomía, aprendizaje digital, divulgación, transmedia, plataforma digital.

## ABSTRACT

Astronomy is one of the sciences that has been involved in the intellectual development of mankind: it has given explanations to the phenomena occurring in the sky and has been significant in the development of societies. Currently, it enjoys importance in recent space research, and new findings are the subject of debate in the scientific community. Unfortunately, astronomy has focused on producing academic content and has neglected public outreach. The topics handle a very technical language that overwhelms and causes confusion; in addition, few people are interested in disseminating its contents and its margin of intervention is short. However, the new digital platforms have promoted the transformation of academic knowledge of science, adapting the traditional way of teaching to one that involves the autonomous learning of people. Therefore, the proposal is to create a digital primer that provides an approach to astronomy from a pedagogical and didactic approach, translating its technical contents into a transmedia product.

**Keywords:** astronomy, digital learning, outreach, transmedia, digital platform.

## RESUMO

A astronomia é uma das ciências envolvidas no desenvolvimento intelectual da humanidade: ela forneceu explicações para fenômenos que ocorrem no céu e foi importante para o desenvolvimento das sociedades. Hoje, ela tem destaque nas recentes pesquisas espaciais, e as novas descobertas são objeto de debate na comunidade científica. Infelizmente, a astronomia tem se concentrado na produção de conteúdo acadêmico e negligenciado o alcance do público. O assunto utiliza uma linguagem altamente técnica que confunde e sobrecarrega; além disso, poucas pessoas estão interessadas em disseminar seu conteúdo e seu escopo de intervenção é curto. No entanto, as novas plataformas digitais promoveram a transformação do conhecimento acadêmico da ciência, adaptando a forma tradicional de ensino para uma que envolve a aprendizagem autônoma das pessoas. Por esse motivo, a proposta é criar uma cartilha digital que forneça uma abordagem da astronomia a partir de um enfoque pedagógico e didático, traduzindo seu conteúdo técnico em um produto transmídia.

**Palavras-chave:** astronomia, aprendizado digital, divulgação, transmídia, plataforma digital.

## Background

Astronomy is a science that has been present in human life since people first became interested in observing the sky. Their curiosity upon seeing a cluster of small bright dots led them to wonder what lay beyond. Thus began their investigation into the behaviors, dynamics, and characteristics of these celestial bodies. Later, they would create a religious connection between their own origins –or the deities– and these celestial bodies, as well as realizing that by measuring cycles –solar, lunar, or astronomical– they could predict certain things such as harvest seasons or biological cycles with a margin of accuracy that was low but reliable for the time.

Over time, scientific tools began to improve and, eventually, religious explanations were left behind, opening the door to the rigorous study of celestial bodies: astronomy. In Colombia, this science arrived in 1780 with the construction of the first astronomical observatory in Latin America, located in Santa Fe de Bogotá. From that point on, spaces for astronomical research and dissemination began to be built, such as Maloka, the Bogotá planetarium, Parque Explora (Medellín), and various universities that provide observation spaces.

Currently, astronomy has several established lines of research, including astrophysics, astrogeology, astrometry, astrobiology, and archaeoastronomy, where professionals and amateurs alike provide added value that enriches the research aspect.

Astronomy has established itself as one of the most important sciences in scientific development, but it has neglected its educational aspect, which has had the long-term effect of discouraging interest among the public, as it requires extensive knowledge of mathematics and physics. However, Sergio Arboleda University, together with other institutions, has research groups that lead and share research focused on astronomy. One of these is SAROS, within the Department of Mathematics, which focuses on general relativity and dynamic systems.

As mentioned above, most research in astronomy lacks communication tools that can increase interest among the public. Therefore, the objective of this work is to develop an interactive digital primer designed to facilitate the teaching of this science among the public. The primer will be designed to integrate the astronomical knowledge provided by the SAROS research group and transform it into accessible program content, using concise and educational language.

The working hypothesis guiding this research is that the creation of an interactive digital booklet with accessible visual and communicative elements can significantly increase interest in and understanding of astronomy among an inexperienced audience. It is hoped that, using modern outreach strategies such as transmedia, social media, and Virtual Learning Objects (VLO), the primer will engage users emotionally and facilitate the learning of complex astronomical concepts, thereby overcoming the traditional barriers associated with the dissemination of this science. The digital design must consider the concepts surrounding this outreach strategy, namely: outreach, transmedia, social media, VLEs, and astronomy.

## Dissemination

Dissemination is the act of “publishing, spreading, or making something available to the public” (Royal Spanish Academy, n.d.), but the term goes further than that. According to Bello (2008), dissemination “requires explanations, adaptations, and contextualization, reformulating content using common terms and resources close to immediate reality to make the transmission of knowledge more accessible, enjoyable, and intelligible” (p. 32).

[Disseminating] involves communicating knowing who I am addressing, how, and through what medium. Here, the role of the science expert shifts to that of communicator, since it is no longer a matter of possessing and understanding knowledge, but rather of how I can make others understand it. (Cardozo, 2022, p. 46)

Taking a different approach, the conceptualization of dissemination places “interest not only in the scientific discoveries of the moment, but also in more or less well-established or socially accepted theories, or even in entire fields of scientific knowledge” (Fundora, 2021, p. 91). Escobar Ortiz and Rincón Álvarez (2018) conclude by stating that dissemination is “a specific form of public communication of science and technology” (p. 138).

## Transmedia

According to Raybourn (2012), transmedia is a “scalable system of messages that represent a central narrative or experience that unfolds through the use of multiple media, emotionally engaging students by involving them personally in the story” (p. 10). For Jenkins (2015), transmedia is a

process in which the integral elements of a fiction are systematically dispersed across multiple delivery channels for the purpose of creating a unified and coordinated entertainment experience. Ideally, each medium makes its own unique contribution to the unfolding story (p. 54).

Transmedia also “includes the set of practices, priorities, sensibilities, learning strategies, and ways of sharing that are developed and applied in the context of new participatory cultures” (Costa-Sánchez and Guerrero-Pico, 2020, p. 3). Based on the above, Coombs (2019) argues that “transmedia storytelling provides a lens for understanding and guiding the use of various social media channels in the distribution of communication” (p. 351). Finally, González-Martínez et al. (2020) comment that “transmedia emerges as a skill or a form of literacy—a new language to be learned and whose rules must be understood—linked to the processing of new types of stories and arguments” (p. 218).

## Social Media

Marín and Almenara (2019) state that social media “are one of the basic tools used in the knowledge society, especially among young people, to the extent that some people are beginning to refer to the younger generations as the ‘silent generation’” (p. 25). Tess (2013), for her part, considers that “social media has become an essential part of personal life as users generate content, share photos, choose ‘likes’ or interact in a game” (p. 60).

Lafaurie et al. (2018) establish that

social networks are defined as a wide range of PC- and mobile-based Web 2.0 platforms or applications that facilitate various forms of communication and the ability to share content among users registered on the site through a profile. (p. 183)

Chávez Márquez and Gutiérrez Díez (2016) believe that “the use of social media facilitates the learning of exact sciences in higher education” (p. 6). In conclusion, Murillo et al. (2017) mention that social media is “a way for young people to interact with each other, creating spaces for open dialogue, which has resulted in the networks where members participate being transformed every time a new member joins” (p. 1107).

## OVA

Botero (2014) comments that “OVAs play an important role due to the way they present content and transfer knowledge” (p. 106). Along the same lines, Sánchez Medina (2014) indicates that these “have come to play an important role in the construction, distribution, and retention of knowledge in 21st-century society, as they can be consulted in different places without time restrictions, simply by accessing the internet” (p. 2).

On a different note, Montaña et al. (2018) state that OVAs “can be used in various educational modalities using different platforms. One of these is augmented reality, which captures elements of the environment in real time using the camera of any electronic device, whether a tablet, cell phone, or computer” (p. 11). Triana and Ceballos (2016) add that OVAs “support the pedagogical role of the teacher and strengthen classroom practice by enriching teaching strategies” (p. 18). Finally, Cabrera Medina et al. (2016) conclude by saying that “OVAs have acquired special significance and importance in recent years, given the way they manage to connect educational processes with Information and Communication Technologies (ICT)” (p. 10).

## Astronomy

Astronomy “is a science with ancient origins practiced by various civilizations; it forms part of the cultural heritage of many societies” (Martínez et al., 2005, p. 13). Iwaniszewski (2009) supports this by commenting that astronomy is “the study of human perceptions of the sky and their relationship to the organization of different aspects of social life” (p. 23). Arias de Greiff (1987) argues that astronomy “has served societies as a tool for their religious leaders in ancient times, or as a support for the expansion of imperial societies in the era of discoveries and conquests” (p. 8).

For their part, Solbes and Palomar (2013) state that “astronomy is the branch of science with the most non-professional enthusiasts, possibly because it deals with issues of interest to human beings: How did the universe begin? How will it all end?” (p. 188). Beltrán (2012) asserts that astronomy “promotes the development of science standards in a very natural and coherent way, as it is always meaningful to students and is perfectly related to the environments they experience in science” (p. 55). García Barros et al. (1997) add that “in astronomy, as in other natural science subjects, the use of conceptual change strategies and activities is proposed” (p. 231).

From another perspective, Galperin (2011) mentions that, within the community in general, “most people have very little knowledge about the subject and, in turn, are not accustomed to looking up to observe the sky and the phenomena that occur there” (p. 2).

Understanding students’ alternative conceptions of astronomy is very important, as this information enables teachers to improve the design, implementation, and evaluation of their lessons in order to achieve better learning outcomes in this area of science. (Loyola and Ortega, 2021, p. 250)

## Methodology

The development of the digital booklet allows us to understand what astronomy is, as well as to create and conceptualize the tools provided by the SAROS seedbed. Through this booklet, a link is created between science and innovative products with digital tools, moving from formulation to the development of structures for constant experimentation.

The goal is to highlight the connection between astronomy and the community using common language, one that welcomes an inexperienced and curious audience that demands high-quality images and simple but concrete texts. The link between scientific academic content and a dissemination strategy focused on astronomical understanding makes it possible to chart a path of knowledge that results in an enriching project for the dissemination of this content.

To better develop the above, this project has been divided into several stages, from fieldwork in remote or face-to-face contexts to participatory design, establishing objectives among actors, issues, and the communication needs of the SAROS seedbed. The creative design includes analysis, collection, and classification of information. Once organized, the initial hypotheses can be considered and the problem broken down into sub-elements, assessing the alternatives that allow for an impactful design and strengthening the retention capacity of a community that is less specialized in the subject but interested in learning about the environment of the stars.

The aim is to disseminate research and share materials that consolidate astronomy as a science of general knowledge through the design of a product that includes the implementation of transmedia strategies, which provide users with a variety of virtual experiences, such as spaces for participation and interactive content that enriches their interest and knowledge. It also serves as a practical guide for teaching astronomy in educational contexts or contexts that are difficult to access.

In summary, the first edition of the booklet is expected to be an interactive resource for communities interested in this vast cosmos. Subsequently, other editions can be created focusing on the development of academic content that addresses other areas of astronomy.

## Results

### *Phase 1. Program Content*

Astronomy is approached in a general and simple way. The program content aims to provide a more detailed and practical conceptual overview based on five topics:

#### *Section I: Introduction to Astronomy*

Given the lack of knowledge about the basics of astronomy, two chapters are presented. The first provides a historical context for this science and how it grew through scientific contributions. The second conceptualizes everything related to movements, measurements, and basic and essential laws of astronomy.

#### *Section II: Solar System*

The solar system is one of the topics that we all encounter superficially in academia. This section consists of five chapters. The first deals with stellar evolution, providing an overview of the history of the universe. The second discusses galaxies and their classification, focusing on the most important ones and their characteristics. The third chapter deals with the solar system, passing through the Milky Way to reach the eight planets that comprise it. The fourth chapter refers to the minor bodies of the solar system—asteroids, comets, and dwarf planets. The fifth chapter is an introduction to the astrometric platform, which is used to measure the minor bodies of the solar system.

#### *Section III: Light and Telescopes*

Light and telescopes are two important concepts in astronomy, which are addressed in five chapters. The first chapter discusses light in the electromagnetic spectrum. The second chapter refers to what a telescope is, its types, and qualities. The third focuses on astronomical telescopes: how they work, their parts, and their construction. The fourth focuses on what can be analyzed with telescopes and what kind of data can be obtained. The fifth addresses images from the James Webb Space Telescope.

## *Section VI: Astronomy, Power, and Architecture*

The fourth section moves from theory to practical cases. Five chapters are devoted to understanding how astronomy relates to power and architecture. The first chapter presents the connection between architecture and astronomy in greater detail. The second chapter discusses hierophanies and sacred landscapes. Building on this, the third chapter focuses on Stonehenge, an important megalithic monument, and its relationship with astronomy. The fourth chapter discusses Newgrange, another megalithic monument. And the fifth chapter discusses Chimney Rock, a site with a strong solar alignment where the community of the same name settled.

## *Section V: Ancient Civilizations and Constellations*

Astronomy was a fundamental tool for civilizations that reached the peak of their development, as it allowed them to measure visual phenomena that were strange to their inhabitants and which they explained as divine signs. The fifth section comprises three chapters that present the development of astronomy in some of the most important civilizations in history. The first corresponds to Mayan astronomy: it explains the role that astronomical science played in the construction of buildings and the measurement of harvest times. The second moves on to the region of Egypt, known for its famous pyramids and the cradle of the concept of ancient aliens. Here, the main focus is on alignments. The third chapter moves to Peru, to the community of the Incas, a civilization that spread from northern Ecuador to central Chile. The section closes with a conclusion on the importance of outreach in astronomy and an invitation to continue learning about this science.

### *Phase 2. Digital Card*

A digital educational workbook is a technological resource that replaces traditional paper-based educational workbooks. It consists of a virtual platform that allows students and teachers to access educational content in an interactive and personalized way. The importance of the digital educational workbook lies in the fact that it provides innovative technological tools to improve learning and teaching. It can include interactive multimedia activities, educational games, self-assessment exercises, and online discussion forums. In addition, it allows students to access educational content anytime, anywhere, increasing flexibility and accessibility to education. It allows teachers to track their students' progress in real time and tailor their teaching to individual needs.

With the consolidation of program content, SAROS seeks to transform textual material into digital material, providing guidance to students and teachers on astronomical topics. This is expected to encourage interaction within the community with regard to astronomical knowledge.

### *Phase 3. Transmedia Design*

Transmedia design is a storytelling and content creation technique that uses multiple media platforms to tell a story or convey a message. In other words, it goes beyond a single medium—a book, movie, or video game—and expands across different platforms—social media, websites, podcasts, comics, etc.

The importance of transmedia design lies in its ability to engage audiences in a deeper and more meaningful way. By using multiple platforms, it creates a richer and more immersive experience, which increases audience participation and generates a greater emotional connection with the story or message being conveyed. In addition, it increases the visibility and reach of the content, as it can be shared and discovered on different platforms. Therefore, transmedia design is a powerful tool for storytelling and effective communication in an era where people consume content on multiple platforms and devices.

When teaching astronomy, this tool can be very useful, as it uses multiple platforms and media and generates more interactive, dynamic, and personalized learning experiences that help students better understand the concepts of this science and how it relates to other areas, such as physics, chemistry, and biology.

## Phase 4. Testing the Primer

The workbook was tested with two different demographic groups. In the first group, consisting of 50 people between the ages of 11 and 17, there was notable interest in the content, which included audiovisual elements. The results showed that young people were more predisposed to engage with materials that incorporated transmedia characters because of their ability to connect emotionally with them and maintain their interest throughout the educational content. However, a significant difficulty was identified related to the length of the booklet, which totaled 144 pages. This extensive format led some students to reach a point of saturation, generally between the first 15 to 20 pages, suggesting a limited resistance to prolonged reading among today's youth.

The second group consisted of 50 individuals between the ages of 18 and 25. Although they shared a similar interest in multimedia content, their attention span varied in comparison to the younger group. They showed continuous interest for approximately the first 40 to 50 pages of the booklet before reaching saturation point. This difference reflects generational variations and preferences in the consumption of educational information.

Both populations demonstrated genuine interest in the multimedia content offered, underscoring the effectiveness of this approach in learning and information retention in an educational context. However, there is a clear need to adapt delivery methods and the length of materials to align them with the attention span and reading habits of each demographic group. These findings highlight the importance of designing educational resources that are not only informative but also engaging and tailored to the preferences of different age groups.

## Discussion

The creation of an interactive digital primer on astronomy yielded highly positive results in terms of the final product, its impact, and its ongoing progress. The focus on creating accessible and visually appealing astronomical content was key to capturing and maintaining the interest of a diverse audience. This aligns with the principles of science communication highlighted by Bello (2008), Cardozo (2022), and Escobar Ortiz and Rincón Álvarez (2018), who emphasize the importance of conveying knowledge in a way that is understandable and relevant to a non-specialist audience.

It was evident that the integration of transmedia and the strategic use of social networks, as emphasized by Raybourn (2012), Jenkins (2015), Marín and Almenara (2019), and Tess (2013), significantly expands the reach of astronomy outreach, as these platforms not only facilitate the dissemination of knowledge, but also promote active interaction and dialogue among users, transforming the learning process into a dynamic and participatory experience (Murillo et al., 2017).

Virtual Learning Objects (VLOs), mentioned by Botero (2014), Sánchez Medina (2014), Montaña et al. (2018), and Triana and Ceballos (2016), played a crucial role in providing flexibility and accessibility in the presentation of astronomical content. The incorporation of VLO, especially enriched with emerging technologies such as augmented reality, facilitates a deeper and more practical understanding of concepts, thus improving the educational strategies employed.

In the field of education, astronomy has not only been shown to enhance science learning, as argued by Beltrán (2012), García Barros et al. (1997), Martínez et al. (2005), and Iwaniszewski (2009), but it has also sparked significant interest among a wide audience, including non-professional enthusiasts (Solbes and Palomar, 2013). This project has consolidated programmatic content that covers the fundamental concepts of astronomy using effective visual resources that facilitate understanding and knowledge retention.

In terms of impact, the project has evolved significantly thanks to continuous feedback and stakeholder participation, which has allowed for adjustments and enhancements to the educational activities offered. As the final content and character design for the booklet are optimized, the project is expected to not only reach a wider audience but also generate a variety of enriching opinions and experiences around learning about astronomy.

## Conclusions

The project has carried out a study focused on evaluating how transmedia strategies and digital narratives can revitalize public interest in astronomy. The main finding has been that the combination of transmedia, such as the integration of astronomy content across multiple platforms and formats, together with the strategic use of social media and virtual learning objects (VLO), can effectively increase the accessibility and appeal of astronomy to diverse and heterogeneous audiences.

From the outset of the project, the hypothesis was that creating an interactive digital primer could transform the way astronomy is perceived and taught. As transmedia and digital strategies were developed and implemented, a significant increase in engagement and understanding among the target audience was observed. This finding validated the initial hypothesis, demonstrating that it is possible to mitigate the perception of complexity associated with astronomy by presenting content in a more accessible and engaging way.

The integration of visual resources, animations, short educational videos, and interactive experiences has been key to achieving this positive impact. These elements have not only facilitated the understanding of difficult astronomical concepts but have also encouraged greater interaction and participation by users, especially among those who may have previously found astronomy intimidating or inaccessible. In addition, the strategic use of social media has allowed the project's reach to extend beyond the physical boundaries of the SAROS seedbed and Sergio Arboleda University. The ability to quickly and effectively share educational astronomy content via Facebook, Instagram, and YouTube has facilitated connection with wider audiences, including students, educators, science enthusiasts, and the public interested in exploring the cosmos.

Despite its success, the project has also faced significant challenges. The ongoing adaptation of transmedia strategies to maintain long-term interest and the sustainability of the project are critical areas that require continuous attention. In addition, ongoing evaluation and feedback are essential to ensure that outreach initiatives remain relevant and effective in an ever-evolving digital environment.

## Statements

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The digital resource presented is available to the public at the following link: **Astro-Tech**. During the study, participants signed an informed consent form to provide feedback on the digital booklet.

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