



Infographics: a didactic resource for current learning and teaching processes

Infographics: a didactic resource for current learning and teaching processes

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Abstract

The text presents the results of the research that, based on the experience of high school and undergraduate students, determined the relevance of infographics as a teaching resource in the learning process. A quantitative approach was used; The design was cross-sectional, exploratory, and descriptive. The research considered the application of an instrument via Microsoft Forms to 749 students from the Autonomous University of Coahuila (UA de C). Among the results obtained, it stands out that the current visual culture has reached the learning and teaching processes, that the information presented through infographics turns out to be very attractive because it allows students to appropriate knowledge efficiently and immediately, and that, at the same time, it is interesting and effective for the learning process that takes place inside and outside educational institutions.

Keywords: Infographic, teaching, learning

Resumen

El texto presenta los resultados de la investigación que, bajo la experiencia de los estudiantes de bachillerato y licenciatura, determinó la relevancia de la infografía como recurso didáctico en el proceso de aprendizaje. Se ocupó un enfoque cuantitativo; el diseño fue transversal, exploratorio descriptivo. La investigación consideró la aplicación de un instrumento vía Microsoft Forms a 749 estudiantes de la Universidad Autónoma de Coahuila (UA de C). Entre los resultados obtenidos destaca que la cultura visual actual ha alcanzado los procesos de aprendizaje y enseñanza, que la información que se expone por medio de las infografías resulta ser muy atractiva porque permite a los estudiantes apropiarse del conocimiento de forma eficiente e inmediata, y que, al mismo tiempo, es interesante y efectiva para el proceso de aprendizaje que se realiza dentro y fuera de las instituciones de educación.

Palabras clave : Infografía, enseñanza, aprendizaje

◆ Introduction



The approach of this research was based on the idea that we are visual creatures with a natural attraction towards graphic representations, therefore, our world has become highly visual (Evans, 2016). Under this idea, the way the brain learns becomes relevant, especially in the learning that is carried out through images, which, according to cognitive neuroscience, have a transcendental effect on consciousness, thoughts and emotions when learning.

We live in a time where generations of students prefer information presented in a brief and concise manner, as a trend that favors the graphic representation of information over written information. In other words, a new way of reporting is proposed, where the format for presenting data allows for immediate and attractive reading and understanding, but is not simplistic and ineffective. This new way of developing a topic is based on the illustration and schematization of information, that is, on infographics.

As teaching material for communicating a topic, infographics can be a powerful influence on the student, as long as the information has an appropriate visual structural treatment. For Minervini (2005), the interest in its use lies in its communicative potential, which functions as a positive tool in the appropriation of knowledge within the teaching and learning process. According to Richter (2013, cited by Abio, 2014), students who use it achieve

increase in information literacy, increase in visual literacy, greater ability to process and interpret information, greater ability to interpret; evaluate, use, and create visual media, increase in technological literacy, as well as the ability to use technology creatively, productively, and effectively. (p.7)

Considering the benefits that the student obtains by using infographics in their learning process, it will be important to also consider what is suggested by Abio (2014), who assures that infographics

seem to be a trend with educational value and should not be ignored as an object of teaching and a form of expression. In fact, we observe that infographics are beginning to be introduced in various work proposals in the most recent language teaching textbooks produced. (p.7)

For teachers, then, it must be of utmost importance to consider the didactic possibilities offered by infographics, since it constitutes an indispensable resource in current teaching processes. This has been suggested by Ferrés (1989, cited by Minervini, 2005), who states that: “if the school wants to build a bridge with society, it will have to fully assume the audiovisual as a differentiated form of expression. That is, in addition to educating in the image, you will have to educate through the image” (p. 2).

Assuming that we live in a visual culture that has reached the learning and teaching processes in educational institutions, infographics are an effective teaching resource that awakens students' interest in learning and that stands as a translator resource of complexities that makes it easier to appropriate the knowledge efficiently and immediately due to its information display nature.

To confirm the approach of this research, it was proposed to measure the relevance that infographics have had as a teaching resource in the learning process of high school and undergraduate students. To do this, an instrument was applied, via Microsoft Forms, to 749 students from the Autonomous University of Coahuila (UA de C). This consisted of a questionnaire of 18 questions focused on answering what the students' experience has been when using infographics as learning material.

Background

For the development of this research, it was essential to know how the brain learns, in particular, when images intervene. Some of the answers were found in cognitive neuroscience, which, as a relatively new science and with the contributions made so far, has shown how fascinating the study of consciousness, thoughts, emotions, and other aspects that are generated is. in the brain from the perspective of learning.

Learning through images is an activity that begins at birth and continues throughout life. For example, if a three-month-old baby hears people talking near him while he is sleeping, the same brain regions are activated in his brain as when he is awake, allowing him to visually recognize the owner of the voice. This is an example of the predisposition of the human brain for learning, and how instinctive it is to educate and be educated.

In this sense, the neurology of learning is presented as a field of study in which teachers can obtain information to apply in their practical and

theoretical work, which can be widely beneficial to improve their teaching-learning strategies and methods.

According to the above, it is important to know if the way in which the brain learns has an impact on the acquisition of knowledge, skills, values or attitudes and what are the brain mechanisms and neural structures that intervene during formal and informal education and how is that they work.

Without a doubt, genetics has a transcendental role in learning and in the disabilities that an individual may suffer. However, according to Frith and Blakemore (2007), it is a proven fact that genetic programming is not enough, since environmental stimulation produced with images, textures and sounds has an impact on the sensory areas of the brain. It is in relation to these stimuli that teachers play a fundamental role as providers of strategies and techniques for learning.

A fascinating idea from Frith and Blakemore (2007) was to propose the teacher as a “gardener” who can sow seeds in the minds of students to stimulate them. You can nourish these seeds with good ideas and important facts, although you can also pull-out weeds, mistakes, and misunderstandings. The idea offers to consider education as a “gardening” of the brain, in which teachers are the gardeners. Thus, they will be in charge of finding the right moments and determining the elements that stimulate the student's brain. Something similar happens with babies born with blindness caused by cataracts. They undergo surgery to recover their vision, and are subsequently visually stimulated, in this way they are able to increase their visual acuity.

The consideration that the brain is instinctively conditioned to learn, regardless of the stage of life an individual is in, has led to the determination that there are different ways of learning. Below, we will mention only those related to the use of images.

Rote learning is the simplest and perhaps the best-known form of learning. In an educational environment it is recurrent as a way of storing knowledge, although with the passage of time what is memorized degrades. This form is effective at certain times and for certain knowledge, such as when learning the vocabulary of a foreign language, the script of a play or a mathematical formula. It is related to the use of imagination to learn; Regarding this, the psychologist Alan Pavio (1960, cited by Frith and Blakemore, 2007) proposed that concrete words were easier to remember (for example, “forest” or “cup”) compared to abstract words (such as “far away” or “pleasant”), this suggested that the former were more imaginable (representable) and that, therefore, by allowing the creation of visual images, learning was enhanced. In fact, we have all experienced that it is easier to remember something when we relate it to an image: we first remember the image of what it is associated with, and the image is what leads us to remember the issue.

The brain turns to visual images when it has difficulty remembering, whether it is impaired or damaged, or because it has a preference or is educated in the visual perception channel. According to Frith and Blake-more (2007), the effectiveness of images as a means of remembering is so effective that they are used as a learning tool in people with chronic amnesia, who are taught to connect concepts with absurd images, such as stories that in reality do not exist. Only in cases where the individual has damage to the back of the brain, the region where the visual cortex is, is the association between visual images and the words you want to memorize not achieved.

Images as a tool of remembrance have been used since ancient times. During the Middle Ages, the Art of Memory was invented, a method that was initially used to remember long speeches that were associated with mental images.

The visual areas of the brain have a determining role in memory, and this, in turn, in learning, which is facilitated when simple concepts can be associated or converted into visual images. In today's era, this technique is used by memory athletes. In a mental imagery study conducted by Eleanor Macguire on Memory Olympics participants (Frith and Blakemore, 2007), brain scanning was used and it was detected that individuals had trained certain parts of their brain to store and retrieve information. This finding allowed us to infer that memory can be trained to remember complex ideas, at least in the short term. Although to develop this ability to memorize and learn with images, training is required, as suggested by the after mentioned study. In fact, the studies considered in this text are accompanied by visual images, which are associated with the explanations and conjectures that they propose.

Another form of learning is one that uses stimuli to associate or evoke imaginable situations, as occurs with the auditory system. And sounds are a source of creating visual images. Studies in this regard show that the association of images with sounds activates areas of the brain that were previously thought to only respond to one modality of stimuli. The study by Désirée Gonzalo and Ray Dolan (cited by Frith and Blake-more, 2007) investigated how things that do not have names, such as sounds and visual symbols, are remembered. The results highlight that the visual areas of the brain responded to a specific color when it was preceded by a previously associated sound, which revealed that the brain quickly adapts to stimuli from other senses, so that the information becomes in imaginable information.

Regarding visual images as a way to achieve learning, it should be mentioned that whenever we imagine, changes are generated in our body, since imagining affects our emotions. The level of learning has a close relationship with the emotion produced by the information acquired. Some studies suggest that bodily effects may occur; For example, there is evidence to support that stress levels could be controlled through

emotional images. Furthermore, the evidence about the relationship between emotions and learning in humans is compelling. According to Ortiz (2015), in the teaching environment it has been shown that when the teacher imposes a strong emotional charge with visual, auditory stimuli and kinesthetic activities as part of their teaching techniques and strategies, students increase their learning and assimilate knowledge; Therefore, it is worth considering the affectivity of emotions in learning. Not for nothing did Jean Piaget say that there would be no knowledge without love. According to this and according to Ortiz (2015), if you seek to impact the student, you must pay attention to the stimuli that are used, since these have an impact on the emotion, which attracts their attention and leads to knowledge.

Another way of learning, one of the most ancient times, it is the imitation that both animals and human beings engage in and consists of observing what others do and then trying to do it yourself. Shortly after birth, humans begin to imitate communicative gestures and continue to imitate throughout life. It is imitated from the simplest to the most complex: gestures, attitudes, values, clothing..., since imitation is a social behavior of learning culture. Hence the popular litany: "you should imitate... so that you learn something." When we imagine being another person, imitating what they do, we create visual images of ourselves in specific situations with the intention of experiencing some learning.

◆ The infographic

The image is displacing the written word, since people (especially the new generations) prefer to learn with images than with written information. This implies directing the transmission of information under a new concept, where text and images contribute to proposing efficient communication. This new graphic concept is the so-called infographic, which goes beyond a simple illustration, as were the geometric diagrams or navigation charts of the 16th century. According to the definition of Belenguer (1999), an infographic is made with graphics made on a computer and serves to transmit information. On the other hand, for Aguilera and Vivar (1990), the relevance of the association between graphics and computing, seen as a technical development in the audiovisual field, has significantly transformed print and audiovisual media by generating representation possibilities that were previously unthinkable.

According to Belenguer (1999), it is essential to differentiate the two applications that infographics have: one is dynamic or animated, and the other is static or journalistic. Dynamic infographics are a creation of moving images generated by electronic means, which emerged in scientific and military laboratories. Today it is widely used in industrial design, architecture, advertising, art, and animated cinema, and it stands out in the areas of scientific imagery and science teaching. It is also relevant in scientific and technical research because it allows the

visual representation of objects and their behavior, and is useful as a communication tool for scientific dissemination.

On the other hand, the static infographics were the result of illustrating and schematizing information for a new visual culture that was born in printed publications, especially in newspapers. This was stated by De Pablos (1991), who defined it as a new journalistic genre, with a new format and a new way of reporting. It became popular in all the newspapers. Nowadays, every day some newspaper presents a topic developed through an infographic. In fact, this way of reporting has given rise to the development of a typology determined by its content. The analysts Peltzer and Aguado (1991, 1993 cited in Belenguer, 1999), have divided it into two groups: view infographics, that is, graphics that explicitly and in detail expose a situation (plans, sections, perspectives and panoramas), and explanatory infographics, that is, visual representations that explain an event, phenomenon or process. This category is subdivided into five types:

- ❖ **Cause-effect:** the cause and effect of an event is illustrated.
- ❖ **Retrospective:** it illustrates how it happened, where, when and why an event happened.
- ❖ **Anticipatory:** an event that is about to happen is illustrated.
- ❖ **Step by step:** the development and sequence of an event is illustrated.
- ❖ **Flow:** the relationships, functions or stages in a process are illustrated.

One more infographic in the explanatory group is the infographic report, which consists of a visual account of a fact. In this there are two subdivisions: realistic infographics and simulated ones. In the after mentioned typology, science explanatory infographics are relevant to our topic due to their usefulness as explanatory instruments. In the field of hard sciences, for example, they are continually dealt with due to the complexity of the topics that require simple explanations so that the non-specialized population understands the phenomena that are studied and the results that are obtained. And, for a scientific fact to be disseminated, it is essential to make a correct interpretation and subsequently give its explanation with appropriate language so that the matter is understood as best as possible (see figure 1.)

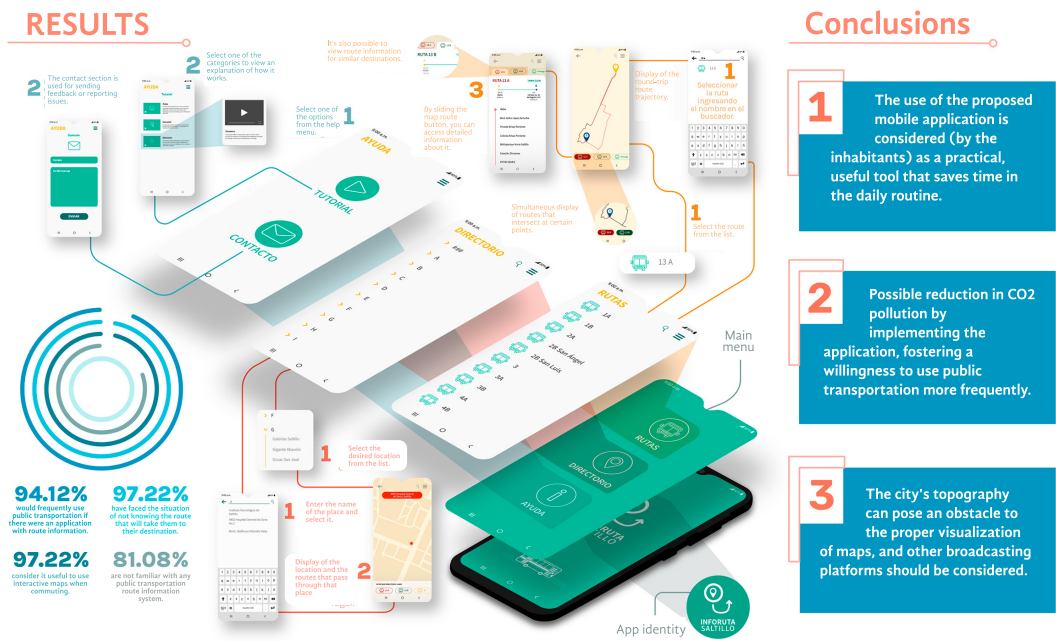


Figure 1. Infographic for the scientific poster: Mobile Application with interactive maps, 2021. Source: Creation of Sandra Marcelina Olvera Cepeda.

Infographic design

Creating infographics for communicating information is not a simple task. The designer of these must know the new visual genre and, in a rigorous manner, the typology of infographics, which will be essential to complement with a method of reasoning, analysis, spatial and visual considerations, in addition to multiple coding skills. This approach proposes for the graphic designer a role as researcher and design facilitator, for which he must be provided with interpretation techniques that allow you to achieve clear and easily digestible graphics. This new role in the area of education may have to consider the collaboration of a pedagogue, an editor, and a psychologist, among other professionals.

Infographics for educational purposes also imply that the choice of information to be communicated is combined with coherence in its aesthetic aspect. With this in mind, it is worth considering what Albar (2013) points out that an infographic must “be direct, very visual, synthetic, attractive, aesthetic, with quick assimilation of the image. The explanatory text must be concise, providing the information or explanation necessary to understand the image or complementing it to enhance it, with appropriate typography” (p. 49). These recommendations, applied to the use of infographics in education, involve considering how a student learns and how images work in teaching a topic.

Now days, for example, it must be considered that we live in a digital age where infographics can be presented quickly through the internet. This gives it a new definition: data visualization, which is based on medium and

purpose, as it encompasses other fields, other perspectives and other visualization functions. According to Edward Tufte (cited by Shaoqiang, 2017), this new approach to infographics consists of the creation and study of the visual representation of data in a digital environment. In his words: “the world is complex, dynamic, multidimensional. The paper is static, flat. How are we going to represent a rich visual world of experiences and measurements on a simple flat terrain?” (p. 5). Until now, Data visualization focuses on the representation of data related to human populations and economic statistics managed by governments. An example of this data visualization is the website: Visually

Infographics as a data visualizer is a new challenge that, according to Shaoqiang (2017), must achieve: “show complex concepts and create fresh and interesting content of high quality and usefulness. The information presented must be understood by any person in general” (p. 5). The interesting thing about this function is that there are no defined techniques, and that it is not limited to specific fields and, even less so, to their forms of expression. Thus, it allows visual imagery as a different perspective on a topic that visualizes data.

◆ Infographics in literature

The current visual culture that new generations of students experience, demands new and attractive ways to become interested in and understand information. And, faced with this phenomenon, education finds in infographics a way to carry out the work of communicating complexities and disseminating knowledge, given its nature as an effective tool to transmit information in an attractive, fast, and concise way within any sector.

The above is supported from a vast number of projects that demonstrate the effectiveness of infographics as a teaching resource in learning and teaching processes. Among them, *Las infografías: Uso en la educación* (Arenas-Arredondo et al., 2021), which analyzed publications between 2015 and 2020 related to the use of infographics in teaching-learning and focused on information processing, production and understanding of knowledge. The results indicate that the use of infographics facilitated the appropriation of knowledge, adapting to any topic, field of knowledge and academic level. The limitations in its application were its preparation and the problems of reading and understanding the instructions, which were unclear for use in the classroom.

Another relevant study is *Las infografías como innovación en los artículos científicos: Valoración de la comunidad científica* (Vilaplana, 2019), whose purpose was to know the degree of acceptance of infographics as a complement to the article. To do this, a survey with a Likert scale was applied to 43 researchers who have published in the *NAER Journal*, which offers visualization of the article in infographic format. According to those surveyed, there was satisfaction with the infographic obtained;

although they stated that their limited technical and time competence limited the use of this resource. The study concluded that it would be ideal for universities and scientific journals to have access to a graphics production service, as is currently the case in newspapers.

Another research in the same sense is *Las infografías como herramienta didáctica: Aplicación en la enseñanza universitaria* (Fernández, 2021), which proposed the use of infographics in university teaching in the Hispanic Philology degree. The work suggested that infographics can be very beneficial for the development of skills in the student due to their qualities to synthesize the information of a subject or topic, and also because the visual exhibition helps the student reflect and understand better.

On the other hand, the work *Uso de infografías como material de estudio en docencia universitaria* (Tárraga et al., 2018) proposed the development of infographics during the training of future teachers. The text highlights that infographics are usually used in the field of the press and advertising, but that they can also be used in the educational field, since their visual nature and their accessibility to make complex topics understandable make them a good academical teaching resource. To do this, it uses the DeFT model, by Ainsworth (2006), as a guide for its development, which helps students better understand concepts that are unfamiliar or complex to them. The study proposes that, once the content of an infographic has been planned, free programs such as Piktochart or Canva can be used to create it. Likewise, it states that infographics in the context of teacher training help to understand complex content, allow the integration of information and communication technologies (ICT) in teaching, and help the professor to become familiar with this resource of great potential for communication and study within the classroom.

One more text that shows the advantages of using infographics is *Investigar, publicar y divulgar. Ciencia en infografías* (EAFIT University, 2020), which brings together more than 50 works by researchers at EAFIT University published as articles indexed in Web of Science and Scopus. Given that the dissemination of science requires a particular treatment to enable complex information to be communicated to the non-specialized public, the use of infographics becomes relevant. This being so, it was through these that a rigorous analysis and treatment of the information was applied, while at the same time creativity and the capacity for synthesis were given free rein when working on the concepts to adapt them to the language and the medium without losing the scientific rigor.

Another project that stands out, now in the digital environment is *Aprendizaje significativo de bioseguridad a través de infografías interactivas* (Díaz, 2021), which identifies the appreciations, attitudes, experiences, and perspectives in relation to meaningful biosafety learning. Its purpose

was to implement interactive infographics as a resource for an educational strategy for teachers and students. To do this, a qualitative study was carried out with the focus group technique, defining basic categories, and applying grounded theory. The study concludes by proposing interactive infographics as part of a teaching strategy that promotes a dynamic, flexible, participatory, and motivating educational process, in addition to promoting meaningful learning, collaborative work and critical thinking in students and teachers.

A work along the same line is *El uso de las infografías como tecnologías de la información y la comunicación (TIC) en el ámbito de la enseñanza universitaria* (Abdala, 2020). It exposes the process of design, production, and pedagogical intentionality of infographics as an interactive teaching resource within the teaching-learning process in the blended modality of the university environment. The study highlights digital infographics as the material that is part of a pedagogical strategy that promotes knowledge and as the medium that articulates the pre-existing audio-didactical resources of the subjects in the students.

On the other hand, the project *The Health Infographics* published by organizations and health authorities on the social network Pinterest (Rivera, 2019) describes the publications of organizations and health authorities in the dissemination of health topics on the social network Pinterest, using a descriptive quantitative research design, non-experimental transversal with the variables: content, dissemination of information and interaction on the social network. The results highlight that the majority of the infographics had a structure that facilitated the dissemination of the contents, which came from reliable sources. In contrast, interaction between users was scarce in relation to the publication of the infographics. The study concludes by indicating that knowing the way audiences behave on social networks allows for the creation of more effective materials for the health area.

On the other hand, the work *Infografías de salud publicadas por organizaciones y autoridades sanitarias en la red social Pinterest* (Pastor et al., 2019) brings together a set of digital infographics made with Infogram and Piktochart in their free version. They were created to support teaching in the subject of Autism Spectrum Disorder, in the master's degree in Special Education, at the University of Valencia. The production of infographics had a positive evaluation as support material in the classroom. The easy identification of key concepts and the recall of information were the relevant aspects.

Lastly, the research *Uso de infografías didácticas para la enseñanza en un sistema e-learning* (Monroy, 2019) determined the incidence of the use of this material in an e-learning educational context. The research had a mixed approach with a sequential and descriptive exploratory design, it used a sample of 12 tutors from the primary and secondary levels who were preparing the material for the course on the platform

and with knowledge of Moodle, computer tools, construction of digital content and experience in virtual learning environments. The results highlight that the use of images on an online platform is a communication language that must handle concepts in a simple and explicit way. Some results were related to other studies that expose the importance of visual language and ICT in a virtual scenario.

Method It was proposed to confirm the approach that we are visual creatures with a natural attraction towards graphic representations, and that these become fundamental as they are one of the most effective ways for the brain to learn. To do this, the relevance of infographics as a didactic resource in learning was interpreted through a quantitative approach research, with cross-sectional, descriptive exploratory design. An instrument was applied via Microsoft Forms with 56 items, of which 18 were related to learning through infographics. The sample was 749 high school and undergraduate students from the UA de C, from 14 centers in the Torreon, Norte and Saltillo units, Mexico.

The reading and interpretation of the results was through the analysis of percentages provided by Microsoft Forms. For this, only the responses of the 18 questions focused on the experience of using infographics as learning material.

Results Using graphs, the preferences for the questions that the instrument applied through Microsoft Forms showed are presented below. Of this highlights that it is much easier for students to understand a topic through an infographic, especially if it is interactive. The students stated that they prefer it because they think it is very useful in the learning process, since the information it contains is enough to understand a topic, in addition to the fact that it requires little time to review it.

Considering the students' responses, it can be assumed that infographics are attractive to achieve valuable and effective learning, which becomes relevant in virtual learning environments.

Regarding the most important purpose of an infographic.

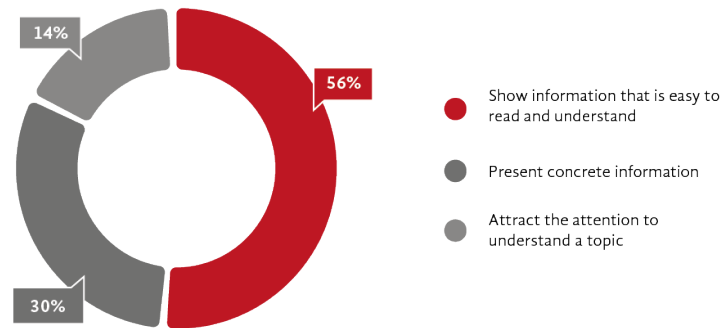


Figure 2. Regarding the most important purpose of an infographic.
Source: self made.

Regarding the most efficient type of infographic to understand a topic.

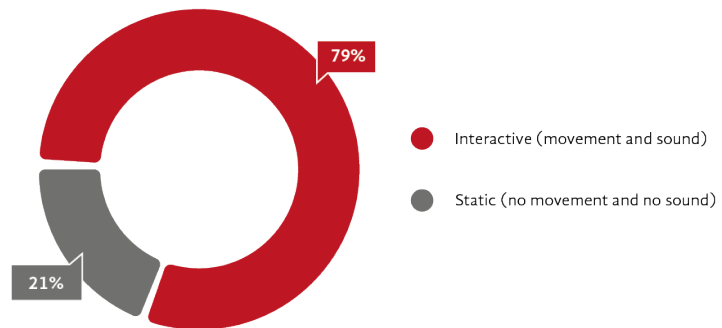


Figure 3. Regarding the most efficient type of infographic to understand a topic.
Source: self made.

Regarding studying a topic, what type of infographic facilitates the understanding of it?

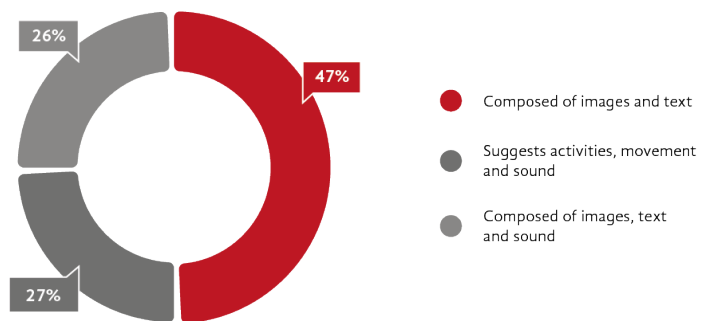


Figure 4. Regarding studying a topic, what type of infographic facilitates understanding of it.
Source: self made.

Regarding learning something about today's world through an infographic.

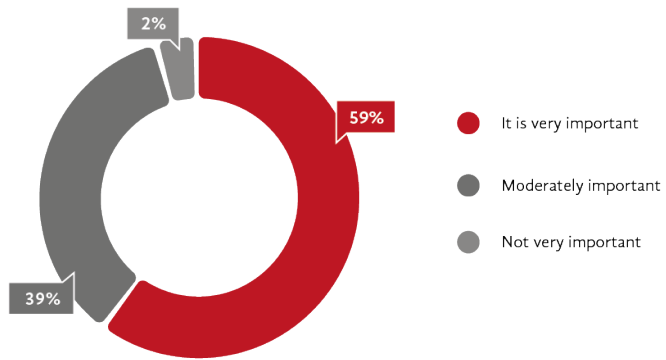


Figure 5. Regarding learning something about today's world through an infographic. Source: self made.

Regarding the help of an infographic to create your own diagrams that allow you to understand a topic.

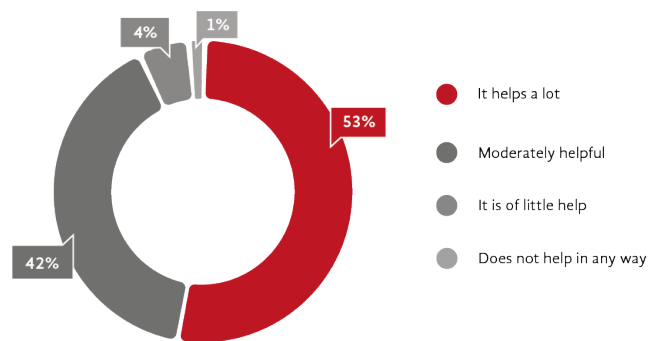


Figure 6. Regarding the help of an infographic to create your own diagrams that allow you to understand a topic. Source: self made.

Regarding the help of an infographic so that oneself can create schemes to study a topic.

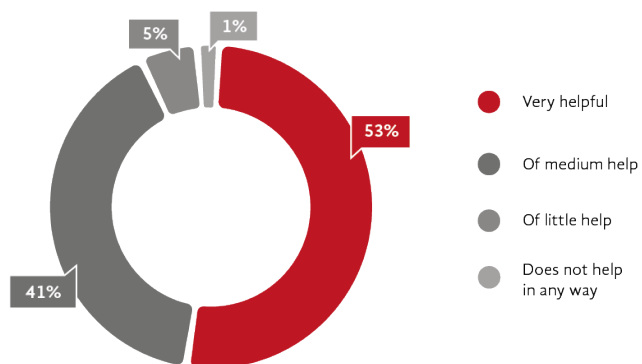


Figure 7. Regarding the help of an infographic so that oneself can create schemes to study a topic. Source: self made.

Regarding the use of infographics as a learning resource.

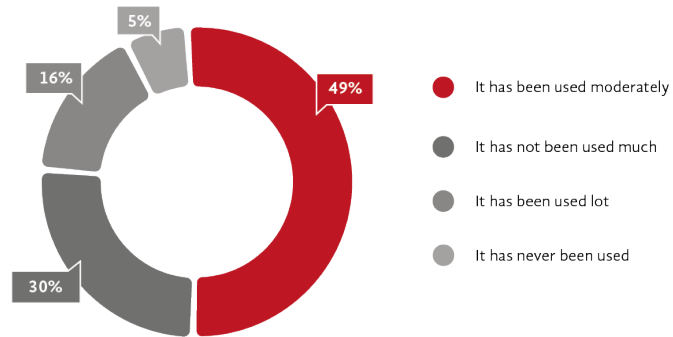


Figure 8. Regarding the use of infographics as a learning resource. Source: self made.

Regarding the help they have gotten with an infographic to apply knowledge in a real situation.

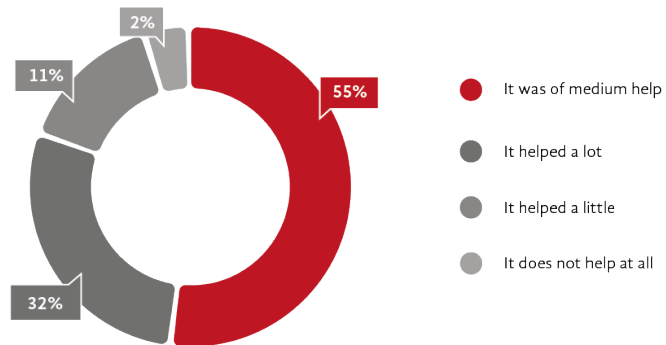


Figure 9. Regarding the help they have gotten with an infographic to apply knowledge in a real situation. Source: self made.

Regarding the usefulness of infographics in virtual learning.

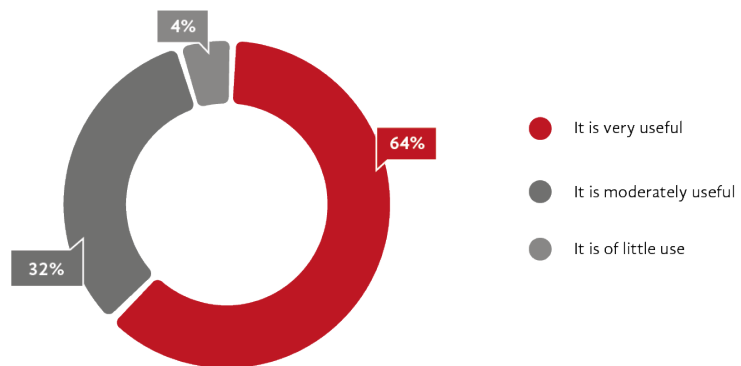


Figure 10. Regarding the usefulness of infographics in virtual learning. Source: self made.

Regarding whether the information presented in an infographic is sufficient to delve deeper into a topic.

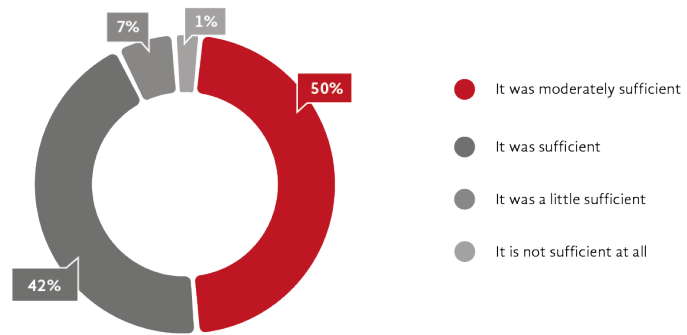


Figure 11. Regarding whether the information presented in an infographic is sufficient to delve deeper into a topic. Source: self made.

Regarding the time spent observing and analyzing infographics to study a topic.

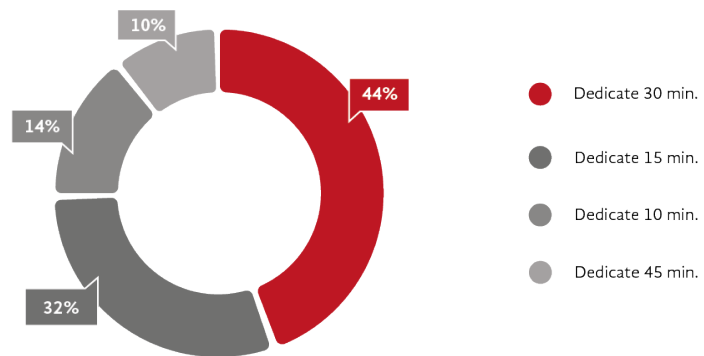


Figure 12. Regarding the time spent observing and analyzing infographics to study a topic. Source: self made.

Regarding the support of infographics to fully resolve doubts about a topic.

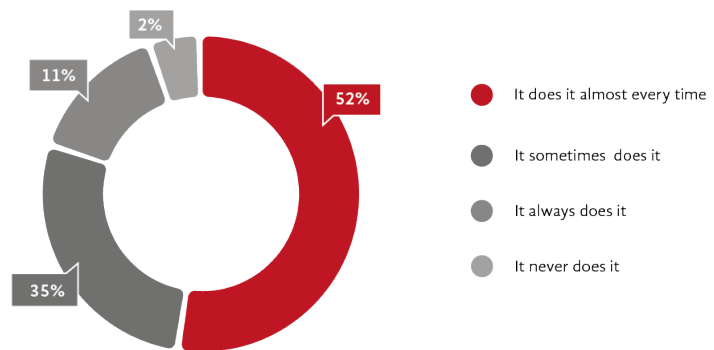


Figure 13. Regarding the support of infographics to fully resolve doubts about a topic. Source: self made.

How necessary they consider it to be for an infographic to include complementary tasks such as readings, talks, challenges or other activities with the intention of improving the experience of a topic?

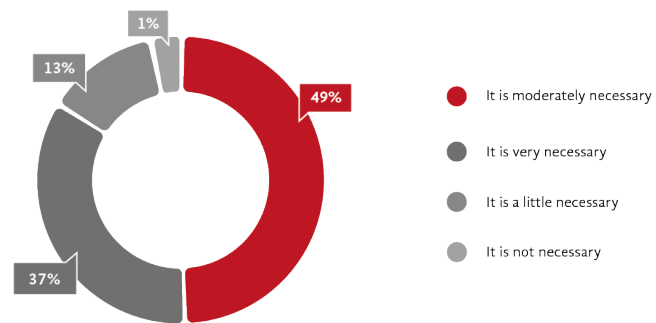


Figure 14. How necessary they consider it to be for an infographic to include complementary tasks such as readings, talks, challenges or other activities with the intention of improving the experience of a topic. Source: self made.

How necessary do they consider it to be for an infographic to include experiences of people that complement the information?

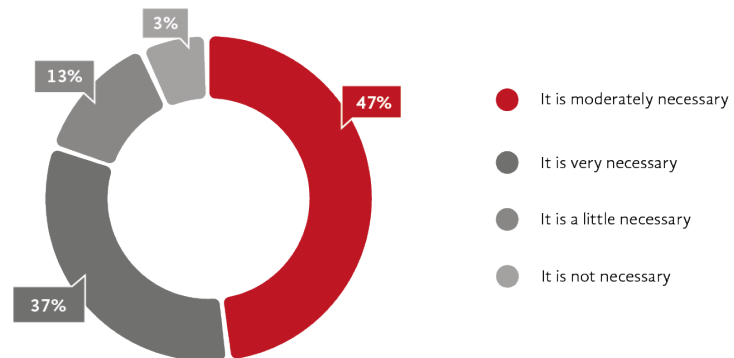


Figure 15. How necessary do they consider it to be for an infographic to include experiences of people that complement the information. Source: self made.

How necessary do they consider that infographics propose the participation of those who consult them?

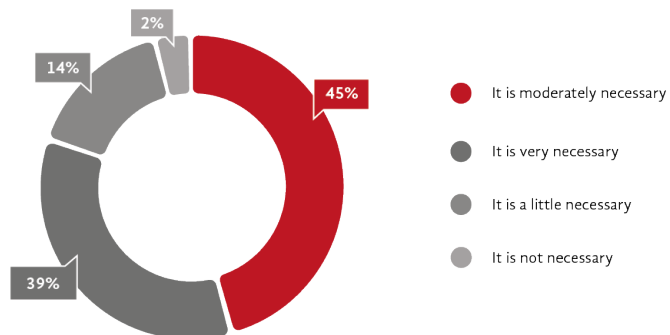


Figure 16. How necessary do they consider that infographics propose the participation of those who consult them. Source: self made.

Regarding how attractive they consider learning through infographics.

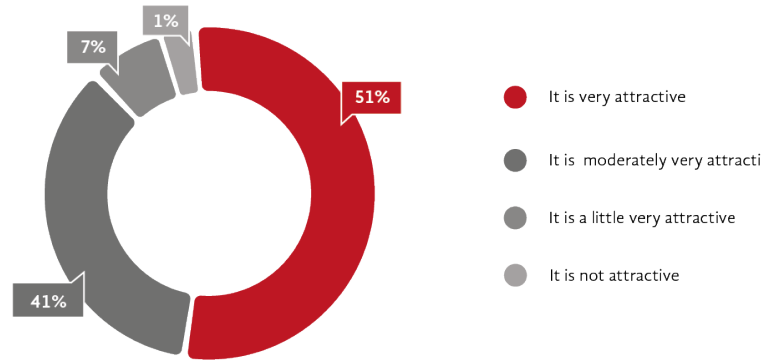


Figure 17. Regarding how attractive they consider learning through infographics. Source: self made.

Regarding considering that learning becomes valuable using infographics.

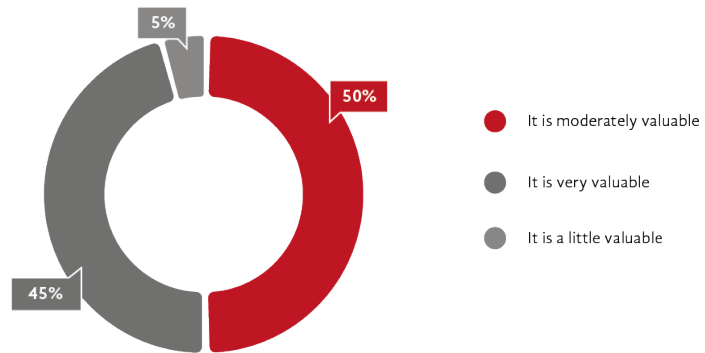


Figure 18. Regarding considering that learning becomes valuable using infographics. Source: self made.

Regarding how effective they consider interactive learning using infographics.

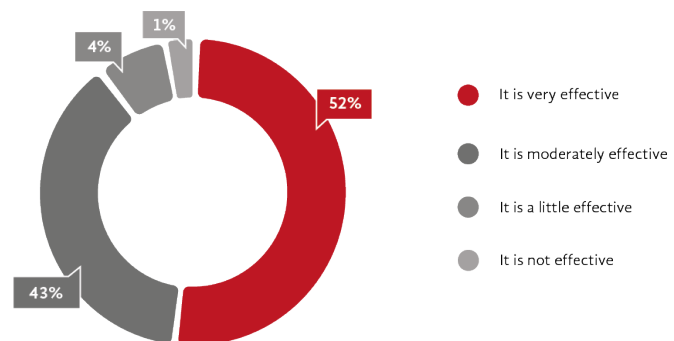


Figure 19. Regarding how effective they consider interactive learning using infographics. Source: self made.

Discussion The interpretation of the results was based on the consideration of the highest percentages. The following inferences resulted from this:

According to the students, the most efficient infographic for understanding a topic is the interactive one, because it has movement and sound, which suggests that there is a preference for interactive material. This predilection goes hand in hand with the opinion that understanding the topics in infographics is facilitated if they are composed with images and text. *Las infografías: Uso en la educación* (Arenas-Arredondo et al., 2021) ensures that infographics facilitate the appropriation of knowledge and manage to adapt to any topic, field of knowledge and academic level. Likewise, *Infographics as a teaching tool: Application in university teaching* (Fernández, 2021) suggests that their use in the university environment is beneficial to develop skills in the student due to their qualities to synthesize the information on a topic.

From the above, teachers can obtain guidelines that apply to their practical and theoretical work. Knowing how students learn when using images allows us to improve learning strategies and methods, while knowing which brain mechanisms are activated and how they work allows us to propose improvements in educational strategies for the teaching-learning process.

For students, infographics are essential because in their experience they have learned something about the current world through them. Likewise, they are significant to them because they have served as a guideline for generating their own outlines and notes as a way of learning.

Students claim to use them frequently to learn a topic. And they also stated that the knowledge obtained has been useful to apply it in real life.

Furthermore, students give important value to infographics because they consider that the information it contains is enough to delve deeper into a topic. In his experience, its use has been primarily to resolve doubts. Their assessment is also influenced by the time spent studying a topic, since they spend 10 to 45 minutes consulting an infographic.

In these experiences, as Frith and Blakemore (2007) have suggested, the environmental stimulation produced with images, textures and sounds impacts the sensory areas of the brain. At this point, teachers are essential, since they serve as providers of strategies and techniques for learning, who know the moments and elements that stimulate the students' brains.

Whenever the imagination is used, changes are generated in our body, and this causes learning. Visual images stimulate our imagination, and this has an impact on our emotions, this means that there is a close, but subtle, relationship between the level of learning and the emotion produced by the information received with images. For this reason, perhaps

students consider it very necessary that infographics include complementary tasks (readings, talks, challenges or other activities) to improve the experience of a topic. Likewise, they consider it very necessary that infographics include the experience of other people, it means, case studies or examples, and that they propose the reader's participation and interaction with the content, whether with questions, activities or tasks.


Since what is memorized is forgotten over time and learning related to the use of imagination could work to remember, given that simple images are easy to imagine and, therefore, to remember, it is important to know the different ways of learning, as well as the channels of perception, to use teaching-learning methods that are in accordance with the way in which the student stores knowledge.

Alan Pavio (1960, cited in Frith and Blakemore, 2007) has already suggested it: creating visual images enhances learning. It is easy to remember something when we relate it to an image, because conceptual connections are facilitated with it. Therefore, learning is very attractive for students when infographics are used that give value to the knowledge that they themselves offer.

The benefits prove that infographics are effective in interactive learning, mainly in the modalities of b-learning, m-learning or e-learning, where you must generate knowledge on your own by following the infographics. In this situation, learning occurs through imitation, the oldest form of learning, which occurs not only at the stage in which an individual is a student, but throughout his or her life.

Conclusions

If it is considered that students receive knowledge through the auditory, visual, and kinesthetic channels of perception, interactive infographics become especially relevant at the time of teaching-learning, since they impact all three channels and, therefore, are established as extremely recommended as appropriate and useful material in autonomous and distance learning.

The environments that form ICT and b-learning allow infographics, especially interactive ones, by their nature, to be the element that amalgamates different learning styles and to be the best means to obtain knowledge, especially when it comes to self-learning. Even more so, considering the time and disposition required by the current student, who has had to adapt for different reasons to new types of learning, such as hybrid and remote, which have become a trend in all school grades. 

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