1-18 En prensa
Antoni Hernández-Fernández
Francesc Morera-Vidal

RSCH grafica documents de disseny gràfic
documentos de diseño gráfico
journal of graphic design

https://doi.org/10.5565/rev/grafica.204

Infographics, a better medium than plain text for increasing knowledge

Antoni Hernández-Fernández, antonio.hernandez@upc.edu, Universitat Politècnica de Catalunya; Francesc Morera-Vidal, francesc.morera@escolamassana.cat, Escola Massana (Universitat Autònoma de Barcelona), España

Abstract
Infographics in social networks present more elaborate proposals than simple text. In this study we analyze the general patterns of Twitter infographic messages to determine its main characteristics. Subsequently, we conducted a test to compare learning differences when young people use infographics instead of text as a source of information. Our findings suggest that while infographics are more effective than text for digitally mediated learning in young people, an analysis of age and gender subgroups showed that this effectiveness was only statistically significant for older people.

Keywords
Infographics; e-learning; social networks; digital survey

La infografia, un mitjà millor que el text simple per l'increment de coneixements

Resum
La infografia a les xarxes socials, presenta propostes més elaborades que el text simple. En aquest estudi analitzem els patrons generals dels missatges infogràfics que figuren a Twitter per determinar les seves característiques principals. Posteriorment, realitzem un test per comparar les diferències d'aprenentatge quan els joves utilitzen infografies en lloc del text com a font d'informació. Els resultats suggereixen que les infografies són més efectives que el text per a l'aprenentatge digital, però una anàlisi dels subgrups d'edat i gènere va mostrar que aquesta efectivitat només era estadísticament significativa per als homes grans.

Paraules clau
Infografia; aprenentatge digital; xarxes socials; enquesta digital

The definitions of the objects of study in visual communication continue to be confusing (Cairo, 2012; Siricharoen, 2013; Dick, 2020). The potential of the visual elements to facilitate learning, cooperation and communication between different communities in a globalized society has not been fully understood. Given the relevance of visual communication in digitally mediated contexts, especially for young people, the general aim of this study is first to define theoretically infographics, through an exploration of social networks, and then show its potential to improve learning.

Furthermore, the relevance of the infographic elements has only been considered tangentially or omitted (Bowker et al, 2015) although the interpretation and analysis of infographics are actively shaping our lives (Dick, 2020). In the Internet age, infographics are conceived to attract more audiences than text because young people prefer narrative forms that combine text with visual contents, and rarely focus on longer texts (Milovanovic & Ivanisevic, 2014). But to act on social networks, in addition to the possibility of connection, other factors must be shaped. We must take into account the ability to use these technologies in context and, after more than two decades of Internet, in online learning some researchers consider young people as a second generation of "digital natives" (Prensky, 2001; Tkalac Verčič & Verčič, 2013) or "Net generation" interchangeably (Sharpe, Beetham & De Freitas, 2010), even if young people may also have some problems in the management of social networks, such as the case of privacy (Scolari, 2018). They are a *post-mail* generation growing up around digital environments, they tend to share intimacy aspects in an online mode (Linne, 2014) and prefer to consume information in a graphic manner rather than in text (Prensky, 2001; Brooke, 2010). The latter notwithstanding, experimental studies are necessary to avoid falling into the "myth" of the "digital native" (Kirschner & De Bruyckere, 2017). Do young people ("*digital natives*") really have significant differences with adults, for example when they learn through infographics?

Some authors claim that the digital distance between adults and young people is mainly socio-cultural, and young people use social media in both non-formal and informal contexts, in a mixed way, meanwhile adults use them in professional and personal areas in a more segmented way (Garrido, Busquet & Munté, 2014). The areas of interest of adolescents in social networks are more diverse and generalist, but adults seem to prefer more specialized topics (Han, Lee, Yea Jang, Jung & Lee, 2016). Young people access information from a significantly narrower spectrum of sources through social media and email, compared to a search baseline (Nikolov, Oliveira, Flammini & Menczer, 2015).

Actually, young people use old strategies --e.g. learning by doing or solving problems-- but in new learning environments such as *Youtube* tutorials (Scolari, 2018). As indicated in Scolari (2018:85), young people receive many transmedia stimuli, which go beyond simple reading, but in informal learning they continue to use the same classic learning modalities (learning by doing, playing, imitating, solving problems, examining or teaching to others). On the other hand, the negative effects of multitasking have been reported and the debate on the adequacy of the definition of "digital natives" is still open (Sharpe, Beetham & De Freitas, 2010; Kirschner & De Bruyckere, 2017).

This work is divided into two parts. In the first part, we have made a terminological effort to define infographics based on empirical data from Twitter. Then, we present a detailed study of visual elements transmitted through Twitter that combine text and image, and consequently we establish manually a gradation of nine types of communicative elements that go from the pure text to the pure image, establishing intermediate levels (4,5,6) as infographics (figure 2). As we shall see, the infographic is defined as a boundary object (Star & Griesemer, 1989) that combines effectively text and image: it is a multimedia visual language of ecdotic character with the property of recursion (see Morera-Vidal, 2017, 2017) and references therein), and with the ability to become a communicative meeting point between different cultures and generations, thanks to the synergetic combination of image and text.

Secondly, a pre-post test study was carried out to compare the effectiveness of the infographic versus the plain text (without image), in a questionnaire about a scientific topic, such as global warming. Thereby we verify if the infographics are more effective than texts for young people's learning (under 30) in an experiment which is digitally mediated. Although it remains a complex theoretical issue, for simplicity we will assume here a functionalist definition of learning (De Houwer, Barnes-Holmes & Moors, 2013), so that if after the presented stimuli the subjects respond correctly we will consider that they have learned. Finally we compare the results obtained in young people with those in adults, in order to check whether or not there is a generational effect that could be associated with the "digital natives" concept (Kirschner & De Bruyckere, 2017).

RSCH grafica documents de disseny gràfic documentos de diseño gráfico journal of graphic design

In short, we carry out a transdisciplinary approach with the aim of bringing advances in visual communication closer to the intercultural and intergenerational studies of digitally mediated communication. In what follows, we start by discussing the relevance of the study of infographics in digitally mediated communication.

Infographics as boundary objects in social networks

Surprisingly, there is no consensus yet on the definition of infographics (Siricharoen, 2013). In one hand, the infographic is not the mere conjunction of text and image: the so-called infographics are descriptive or narrative stories which aim to be visual alternatives to traditional texts or audios, which propose effective solutions in multicultural communication, increasingly improved as a consequence of digital development in visual communication. In fact, infographics are optimal for social networks and digital platforms, taking advantage of all the opportunities offered by these technologies in a natural way (Morera-Vidal, 2018).

Dick (2020), like Cairo (2012) and other authors understand the concepts of "infographic" and "data visualization" as interchangeably. We argue that data visualization is a category included in infographics. The narrative aspect of the infographic (explanation) can include elements of visualization (description). Although both products can display data, the infographic representation can contain visualizations. On the contrary, visualization cannot.

On the other hand, if we define boundary objects as representational forms that can be shared between different communities, with each community holding its own understanding of the representation (Star, 2010; Timmermans, 2015), the creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds (Star & Griesemer, 1989), what is usual on the Internet, where individuals from different communities share content. Classically, according to Vygotsky (1962, 1978) two qualitative leaps occur in the individual over his development: the first one takes place when the subject acquires the oral language, while the second takes place when the subject acquires the written language. We could speculate that, with the advent of visual language, we are facing a third qualitative leap that will become increasingly important in the context of digitally mediated societies.

For what said above, a detailed analysis of communication through infographics in contemporary digital culture is essential, since they have become one of the most relevant activities, encompassing both tools and signs (Vygotsky & Luria, 1994), acting as mediator in the transmission of digital information. Previous works have suggested that infographics are not only more effective but also more permanent in the minds (Ozdaml, Kocakoyun, Sahin & Akdag, 2016).), and become *standardized forms* (Star & Griesemer, 1989; Star, 2010; Bowker et al, 2015) of the digital media that enable coordination (or collaboration) across the communicative frontiers between different communities (Engeström et al, 2015).

Previous studies have shown that the design of the structure of the visual message is crucial. This infographic message can be divided into formal groups with a semantic nature combining text and image, so the reader may tend to follow visual paths that had not been considered by the designer of the infographic (Siricharoen, 2013). In this sense, Ware (2008) warns about two models of perception in the act of vision: "a) Bottom-up: information drives pattern building and b) Top-down: attentional processes reinforce relevant information". So, the reading of the infographic message is done in two levels: one direct level, so-called "insight", in which the reader realizes the type of visual message that has before it and, subsequently, a more detailed reading level where the information is accessed and ends up obtaining an interpretation of the full message (Ware, 2008).

Infographics have a marked intertextual character (Bloome & Egan-Robertson, 1993) and its processing goes beyond reading the written texts that they usually include: it is a communicative amalgam between image and text that transcends the mere image or text. This transversal conception of infographics is typical of *transmedia* narratives and multichannel languages, as Valero Sancho (2017) pointed out (figure 1), curiously without noticing the potential of Star's ecological approach (Star, 2010; Star & Griesemer, 1989; Timmermans, 2015). In Valero Sancho's (2017) approach, the main idea is that in visual communication each of the five fields represented in figure 1 (*Communication, Calculus, Computing, Art and Other disciplines*) intersects with the others. Then, relevant partial intersections emerge between disciplines.

Under this theoretical framework, the infographic is considered as central in visual communication and needs the contact of all the disciplines involved. While one could e.g. imagine that an infographic could be done without the help of computers (i.e. manually drawing it) and/or min-

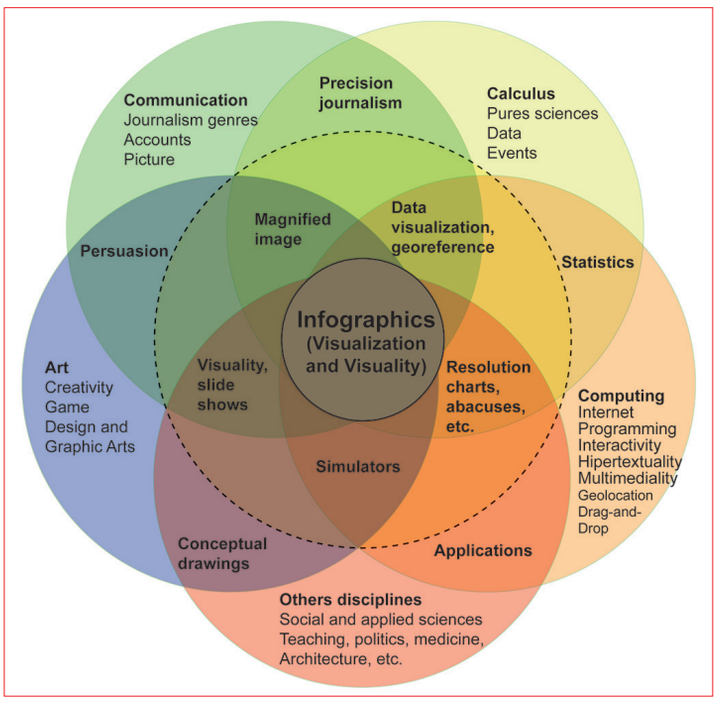


Figure 1: Diagram of the fields of knowledge and uses of the infographic in the analogical and digital fields according to Valero Sancho (2017).

imizing the influence of the other five theoretical fields represented in figure 1, the opposite is true in practice, and neither *Art*, *Computing*, *Calculus*, mass-media *Communication*, nor of course the *cultural and social* component (*Other* in figure 1) can be ignored.

This approach may seem reductionist, and perhaps it groups under 'Other' too many fundamental components of visual communication (i.e. educational and socio-cultural), but exemplifies the interrelation between very diverse disciplines, something typical of ecological approaches and boundary objects (Star & Griesemer, 1989; Star, 2010; Bowker et al, 2015). As a consequence, infographics could be considered boundary objects, specifically intercultural digital "standardized forms" (Star & Griesemer, 1989), because technically they are elements of common digital communication across dispersed groups.

Approach and methodology

We face two studies in this work. The first (part one) is theoretical, although based on empirical evidence: to explore and describe infographics as visual statements of effective communication in social networks (here, Twitter). We use qualitative and quantitative methods that have previously been found in visual elements (Valero Sancho, 2012; Morera-Vidal, 2017). This characterization allows us to define and locate technically the infographic in the digitally mediated communication. After that, in the second part we explore if infographics are better in digitally mediated learning than the simple text. A pre-test and post-test experiment is carried out to verify the learning effectiveness of infographics with respect to plain text in young people (under 30), comparing the results with adults (over 30 years).

Part one: describing infographics

A corpus of Twitter visual statements has been collected for analysis, following Valero's model (Valero Sancho, 2001). Twitter is one of the most active social networks, whose conciseness (maximum 140 characters) and immediacy make it a communication environment where all types of symbols, labels and images coexist with the text in an unprecedented way (Tascón & Abad, 2011). The collection of samples was done between February 2012 and April 2016, and was limited to static files that users attach as visual elements and that have the usual extension in image files (jpg, png or gif; tiff and bmp are not allowed in Twitter, and dynamic .gif files could not be included in Twitter until October 2015). They are one-page full-view files in a single visual scan without the need to press additional buttons or tabs. Samples were collected indiscriminately, according to the still controversial defining standards of the concept of infographics (Cairo, 2012; Dick, 2020; Morera-Vidal, 2017; Siricharoen, 2013).

In this semantic and qualitative analysis, to specify which visual statements could be considered fully as infographics we follow the theoretical precedents of Wileman (1993). We use a scale of relationship (Figure 2a) between the text and the image of nine levels based on Molitor, Ballstaedt & Mandl's (1989).

Finally, 1382 visual statements were compiled, at an approximate rate of 1.2 daily files that rule out the accumulation of visual elements of the same trending topic. Thus, no file was rejected because it was not clearly considered as infographics, such as images without textual elements or text in which only the typeface or color font varied (Figure 2). Given the characteristics of this social network, all the infographics were shared by young users (considered being under 30 years of age in this study), whether they were followers of the author or that they were followed by him. Therefore, there could only be a thematic bias in the selection of visual elements.

RSCH grafica
documents de disseny gràfic
documentos de diseño gráfico
journal of graphic design

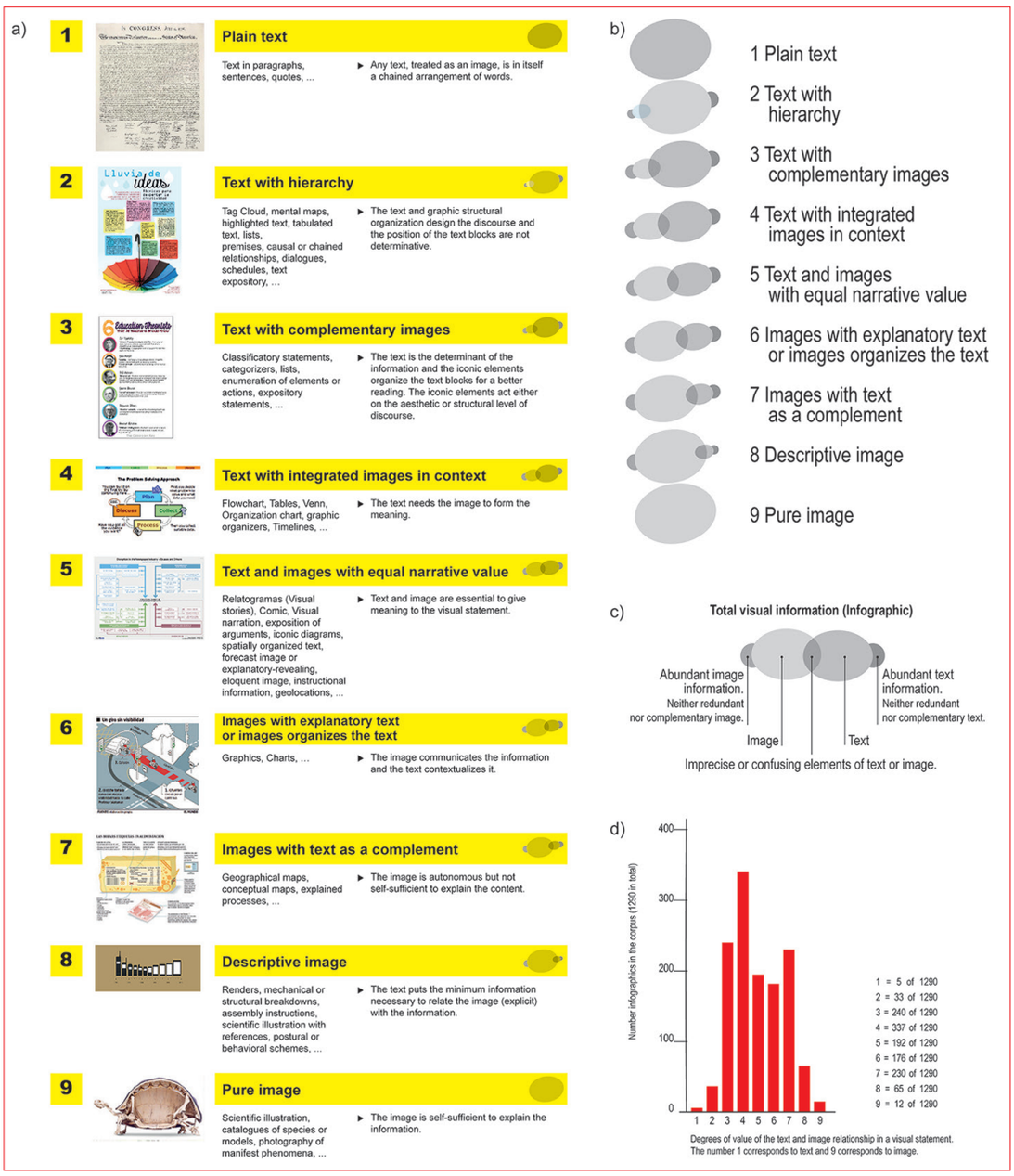


Figure 2. a) Scale of visual elements considered in this study. From 1382 elements initially recorded, 92 elements were discarded and finally 1290 were manually classified. b) Diagram showing the relationship of text and image in each of the nine degrees of the visual statements from those containing plain text to those containing pure image. c) Venn's diagram of text and image distribution in visual statements, based on Molitor, Ballstaedt & Mandl's (1989) scheme. d) Bar plot of the number of analyzed samples of each visual type (total N=1290 infographics).

We consider that the infographics corresponds to levels 4, 5 and 6 on that scale. In these cases, the text and the image work closely to complement the information and both are linked to form a superior communication object.

In Figure 2 (panel *a*) we show a scale of nine levels that goes from plain text to image. Approximate interrelations between text and image are schematized in terms of Venn diagrams in panel *b*) (Morera-Vidal, 2017), according to Molitor, Ballstaedt & Mandl's (1989) scheme (panel *c*). Finally, in panel *d* we depict the distribution of collected

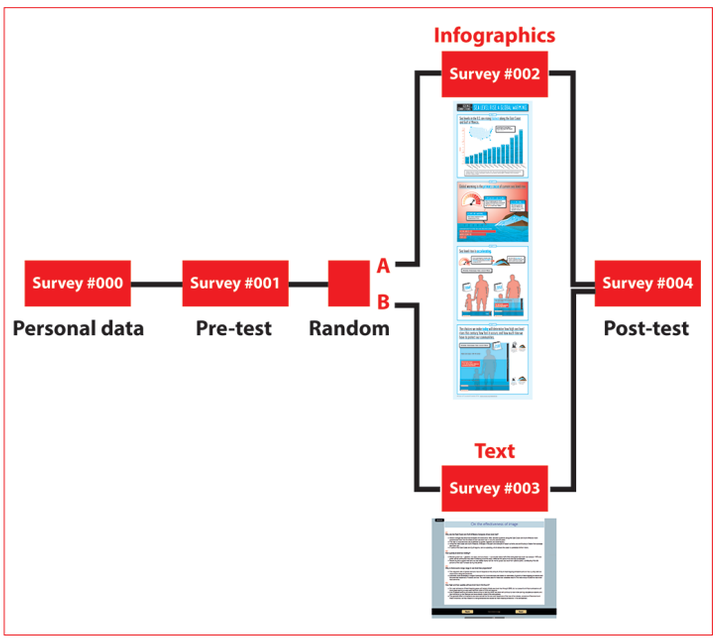


Figure 3. Development scheme of the comparative test. See survey details in SI..

items.

Part two: infographics as an effective way of learning

We proposed an investigation to compare the infographic with the text as an effective way of learning, with a sufficient sample to obtain external validity (Wimmer & Dominick, 1996). For this purpose, a pre-test / post-test questionnaire was prepared with a control group in a digital context of normalized conditions, in a specific topic (in our case "global warming"). Indeed, a text (control group) and infographics with the same textual information but complemented with images (experimental group) was supplied. Figure 3 shows the test development scheme.

The study was carried out with the online *SoGoSurvey* platform. During the questionnaire the participants could not go back. There is a maximum time of 5 minutes for each of the phases, with a total time of 20 minutes. Following Ziefle (1998), it was considered that it could be done comfortably in 12 and 15 minutes. The methods are explained in Suplementary Information (SI). The questions (both in pre-test and post-test) and possible answers (in bold those considered correct) are summarized in table 1 in Suplementary Information (SI).

The statistical analysis was performed with the software SAS v.9.3. and R package *sjstats* (Lüdecke, 2021). There was a total of 403 participants, of which 108 abandoned the process in the first two levels (Survey # 000 or Survey # 001), 200 formed the experimental group that observed the infographics (Survey # 003) and 95 the control group (which read the texts, Survey # 002). Participants randomly chose the route (Infographics or Text) and the preliminary Chi Square Test ruled out that neither age, nor gender, nor level of education (more than 82% in all groups had university studies) or previous experience in this kind of surveys influenced early abandonment (Table 2 in SI).

A total of 295 subjects finalized the test, 115 under 30 years (57.5%) in the group of infographics (200 in total) and 43 (45.2%) under 30 in the control group (95 in total). In the experimental group, 46.5% identified as women and 52% as men (1.5% preferred not to indicate their gender) whereas in the control group 42.1% identified as women and 56.8% as men (1% did not indicate their gender). In the sample "under 30", 49 identified as men (42.6%) and 66 as women (57.4%) in the experimental group, and 16 as men (37.2%) and 27 as women (62.8%) in the control.

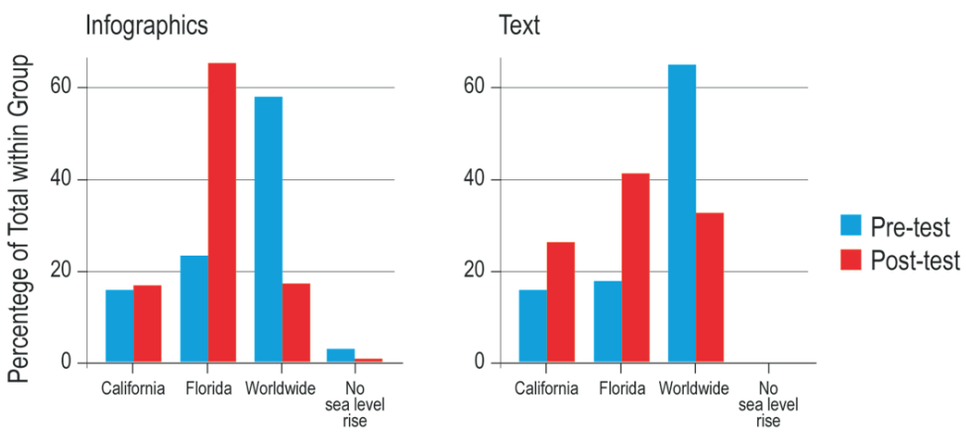
The abandonment of the post-test is statistically more common among users (young and old) who do not answer the pre-test questions correctly (see SI). Previous experience in knowledge about image treatment was not a determining factor in the early abandonment of the questionnaires. Although the residence factor has not influenced this study as we will see, it can be said that more than 80% of the sample resides in Barcelona and its surroundings, so the cultural environment is mostly that of the Mediterranean area of Catalonia, in southern Europe (82.5%) and the rest come from other European and American countries (17.5%). In short, although the topic of the study can be considered quite transversal and independent of cultural factors (being a scientific topic related to climate) it could be argued that the study sample shares a large part of socio-cultural elements and is, in this sense, homogeneous.

Results

Infographics and learning

To assess the effectiveness of infographics in learning regarding the text, the intervention was stratified and the Cochran-Mantel-Haenszel statistic (CMH) was calculated. In figure 4 a case in which infographics varied much more than the text the correct answer to one of the questions is presented (Q2). The same tendency happened for all questions, in young and old people, regardless of gender, except in question 4 (see Figure 5).

RSCH grafica
documents de disseny gràfic
documentos de diseño gráfico
journal of graphic design



Q2. Where do you think the sea level rise is more pronounced?

	Experimental (Infographics)				Control (Text)			
	Pre-test		Post-test		Pre-test		Post-test	
Q2.	Percent	Count	Percent	Count	Percent	Count	Percent	Count
No response	1.5%	(n=3)	19.5%	(n=39)	1.0%	(n=1)	18.9%	(n=18)
California	15.5%	(n=31)	13.5%	(n=27)	15.7%	(n=15)	21.0%	(n=20)
Florida	23.0%	(n=46)	52.5%	(n=105)	17.8%	(n=17)	33.6%	(n=32)
Worldwide	57.0%	(n=114)	14.0%	(n=28)	64.2%	(n=61)	26.3%	(n=25)
No sea level rise	3.0%	(n=6)	0.5%	(n=1)	1.0%	(n=1)	-	-
TOTAL	100.0%	(n=200)	100.0%	(n=200)	100.0%	(n=95)	100.0%	(n=95)

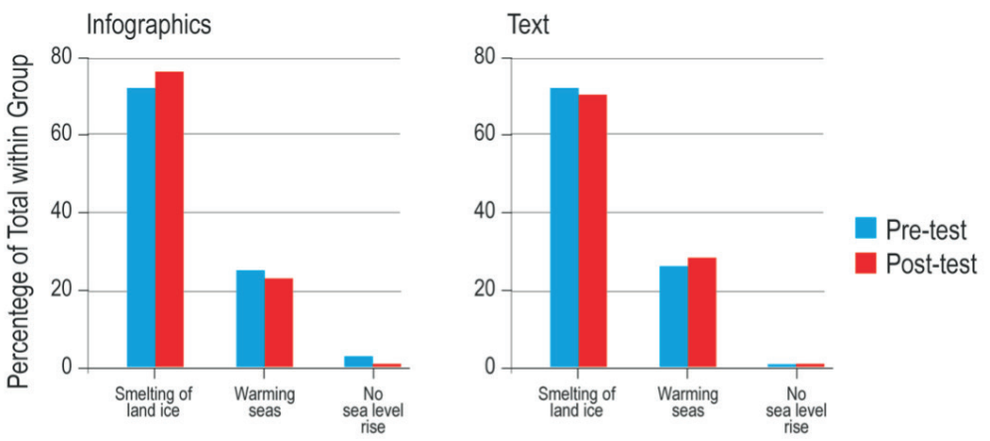
Figure 4. Example (question 2) where infographic shows better influence than text in the transmission of knowledge (CMH General Association Statistic, $p<0.0001$). The results in this case are shown grouped for all participants.

ANOVA test shows that while there are no significant differences in test results between groups in young users (Infografics vs Text) in the pre-test (Df = 1, Sum Sq.= 1.0, Mean Sq.=1.0061, F=2.013, p=0.156), but there are in the post-test (Df = 1, Sum Sq.= 4.0, Mean Sq.=3.961, F=7.287, p=0.007**), so that the group to which the infographic is applied significantly improves learning (see Table 3a, 3b and 4 in SI, and figure 6), which is not the case in the control group that only received texts as learning material. On the other hand, an analysis of age and gender subgroups using the Cochran–Mantel–Haenszel test showed that this effectiveness was only statistically significant for older men, under this more strict test (see Table 5 in SI).

However, in the Likert type questions the evolution is similar in men and women, without significant differences by age or gender, although young men respond slightly better to infographics. Figure 6 shows this evolution in the responses (pre and post test) of young men and women. Indeed, infographics are more effective than texts in learning in all participants, when considering the full sample (see Tables 3a, 3b, 4 and 5 in SI). Other factors such as variations in the user location, previous experience or level of studies of the respondents did not significantly influence the results of each subgroup.

Conclusions

Classical studies on the learning and reading of visual statements (Levin & Divine-Hawkings, 1974), as well as the relationship between text and image in learning processes (Levin, 1989) and hypertextuality (Horn, 1998), anticipated that



Q4. Since 1972, sea level rise is due mainly to:

	Experimental (Infographics)				Control (Text)			
	Pre-test		Post-test		Pre-test		Post-test	
Q4.	Percent	Count	Percent	Count	Percent	Count	Percent	Count
No response	2.0%	(n=4)	19.5%	(n=39)	1.0%	(n=1)	17.8%	(n=17)
Smelting of land ice	70.5%	(n=141)	61.5%	(n=123)	71.5%	(n=68)	57.8%	(n=55)
Warming seas	24.5%	(n=49)	18.5%	(n=37)	26.3%	(n=25)	23.1%	(n=22)
No sea level rise	3.0%	(n=6)	0.5%	(n=1)	1.0%	(n=1)	1.0%	(n=1)
TOTAL	100.0%	(n=200)	100.0%	(n=200)	100.0%	(n=95)	100.0%	(n=95)

Figure 5. Statistics of the only question of the test (question 4) in which infographics did not significantly improve the responses of the participants in the post-test (CMH statistic with p≈0.36). The results are presented here for all participants.

visual language is an essential part of communication, what is especially relevant in the context of the current digital social networks in which we live. On the other hand, efforts to understand learning processes and their dynamics currently challenge the traditional definitions of learning and education (Kumpulainen & Erstad, 2016), and are undoubtedly one of the most important challenges of the Big Data era.

We should have always a clear definition of an element when we introduce it in the teaching-learning processes. In the first part of this work, after a detailed study of visual elements transmitted through Twitter we have discovered that it is not possible to date to distinguish the infographics automatically. Hence we still need human intervention, through semantic classification, to differentiate the infographic from other visual communicative levels (Figure 2). This fact maintains subjectivity in digitally mediated experiments with infographics, which poses a challenge to Evidence-Based Teaching (EBT) approaches, where the scientific method is intended to be applied (Groccia & Buskist, 2011).

In the second part of this work (pre-post test study), assuming a functionalist definition of learning (De Houwer, Barnes-Holmes & Moors, 2013), we show that infographics are more effective than texts for digitally-mediated learning. But when we compare the results obtained in young people and adults we don't find that the so-called "digital natives" (Prensky, 2001) score substantially better than adults (tables 4 and 5 in SI), providing evidence that the conception of 'digital natives' might be a pedagogical myth (Kirschner & De Bruyckere, 2017). Infographics can therefore improve the learning of everyone, including young people (see Tables 3a, 3b and 4 in SI), but

RSCH grafica
documents de disseny gràfic
documentos de diseño gráfico
journal of graphic design

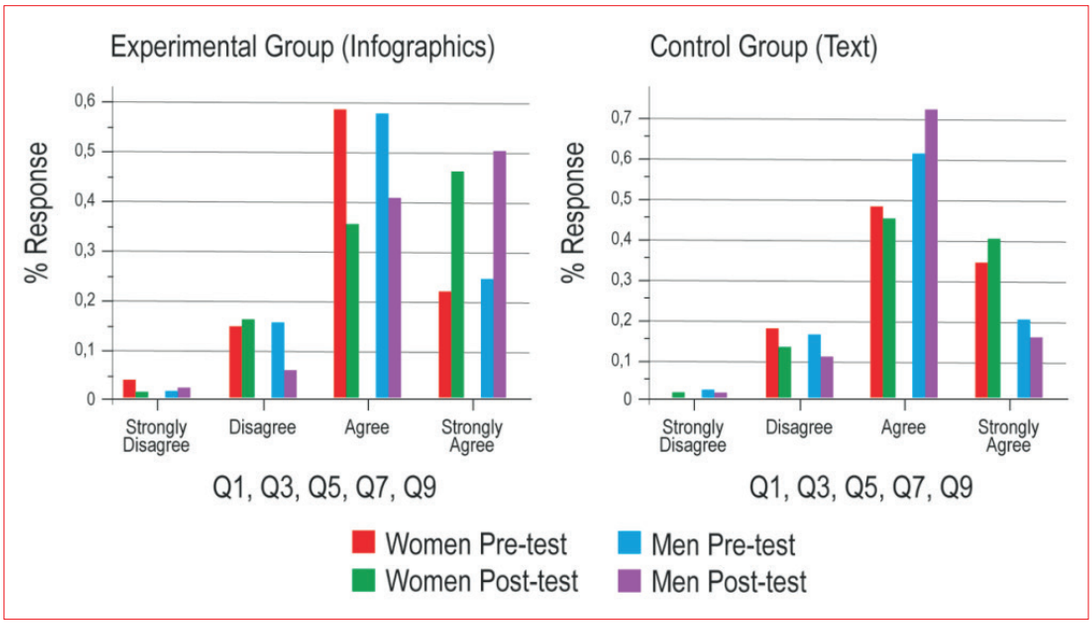


Figure 6: Evolution of the responses of the young users in the pre-post test study (odd questions) of the experimental group (infographics) and control (text). "Strongly agree" and "agree" are considered correct answers. The ANOVA test shows that there are no significant differences between groups in the pre-test (Df = 1, Sum Sq.= 1.0, Mean Sq.=1.0061, F=2.013, p=0.156), but there are in the post-test (Df = 1, Sum Sq.= 4.0, Mean Sq.=3.961, F=7.287, p=0.007**).

an analysis of age and gender subgroups using the Cochran–Mantel–Haenszel test showed that this effectiveness was only statistically significant for older men (Table 5 in SI).

The fact that age is not a relevant factor in the abandonment of the performed test (Table 2 in SI) is significant and goes against some retrograde conceptions that tend to assume that young people are more inclined not to finish tasks or to abandon them prematurely, especially if these require an effort. The initial dropout rate in our test neither depended on age, nor on other factors such as gender, level of education or previous experience. Even so, the test has been carried out in a digitally mediated way, which could have been a determining factor for young people not to leave early. The percentage of dropout is greater in the users who had responded wrongly, which could be a consequence of discouragement because they consider that have not learned enough or do not finally master the subject. However, the abandonment in the post-test is higher in the older than in the young people, and more so in men than in women.

The latter allows us to hypothesize if young people, when faced with digitally mediated tests, tend to finish more this type of test than older people, but more studies are needed to corroborate this. This could be due to a greater adaptation to the digital context, mediated by the screen, so that young users could take more as a game the test and have a greater tendency to finish it, even though they are aware that their answers might not be correct. The fact that older men are users who tend to leave the test earlier, being aware that they are not responding correctly, may be because they receive greater social pressure not to recognize their mistakes. Do they prefer to abandon the test to acknowledge their ignorance? This psychosocial aspect of masculinity should be explored in more detail, but in our case it has been another factor to consider for future work.

The public and massive character of Twitter has made it impossible to differentiate the shared elements only by young users. Accordingly, future statistical studies are necessary to verify whether young users share more or less infographics (or other elaborated visual contents beyond the mere image) than the older users. For instance, a lower exposure of young users to infographics could explain their slightly worse results in the test, although this should be checked properly. Studies on Twitter's potential in learning have focused on written rather than visual language (see Rosell-Aguilar, 2018 for a review) overlooking the potential of the shared image in the networks.

The same should be verified regarding the slight gender differences that we found: men (young and old) seem here to respond slightly better than women to the visual language of infographics (figure 6), in the line of some studies that point to better masculine capacities in the processing of visual information (Shaqiri et al, 2018). A recent report from European Commission (2018) confirms that the gender gap in relation to internet usage exists only among individuals over 55 years old, and such gap has completely closed among those aged 16 to 25 and 25 to 54 years. Gender differences for the type of uses of the internet are also narrowing. In our test these slight differences between genders have been found in all age groups. There are different studies that conclude that sex differences in general intelligence are negligible (i.e. non-verbal and verbal ability across development), although sex differences persist in certain, specific cognitive domains such as in visuo-spatial ability (Toivainena, Papageorgioub, Tostoc & Kovas, 2017; Savage-McGlynn, 2012; Kersey, Braham, Csumitta, Libertus & Cantlon, 2018; Shaqiri et al, 2018).

According to the results of the 2015 PISA program about 15-year-old students (PISA, 2015), those students who access the Internet, chat or use social networks outside school score slightly higher than other students, and on average across OECD countries, girls score 29 points higher than boys. Could these differences in PISA be due, as a factor, to a pre-eminence of educational materials in text form with respect to visual elements such as infographics (which would favor boys slightly)? Let us recall that Li (2014) suggests that women generally score higher than men on verbal memory tasks, object location or recognition as well as verbal memory tasks, with differences in cue use and spatial memory (Jones & Healy, 2006), while the opposite is true for spatial mental rotation and navigation tasks.

Our findings suggest that infographics are boundary objects (Star & Griesemer, 1989) that help people to learn better than through plain text. Yet infographics are not statistically very much present in Twitter: in the sample taken in this study, only 192 visual elements of the 1290 considered were strictly infographics, which is a relatively low percentage (14.9%). Even more, if we consider the visual elements that are shared daily in other social networks, in our sample infographics probably would be overrepresented, since the infographics would represent a much lower percentage of the total shared visual content, given the preponderance of photography in all networks, especially in Instagram or Pinterest, and the tendency to create images that are mere text endowed with a colored background and a basic typography, in Facebook or Twitter. Leisure predominates in the social networks of young people, so the elements that are shared do not seem to be oriented to learning.

However, more field studies are needed with even larger samples. Although the survey was universally distributed in English, geographic areas in Asia and Africa were not accessed; thus, the limitations of this research are of a geographical nature with restrictions due to language or Internet access. In future phases of this research, it could be limited in specific areas for greater control of the data and people surveyed. Other future lines of research are oriented to the study of digital infographics as a bitmap message. Finally, our results should encourage educators to introduce more infographics as teaching materials, alternative or complementary to texts, whether in digitally mediated or traditional contexts.

RSCH grafica documents de disseny gràfic documentos de diseño gráfico journal of graphic design

Referencias bibliográficas

Barron, Brigid (2004). Learning ecologies for technological fluency: Gender and experience differences. Journal of Educational Computing Research 31 (1):1–36.

Bloome, David, & Egan-Robertson, Ann (1993). The social construction of intertextuality and classroom Reading and writing. Reading Research Quarterly, 28, pp. 303–333. doi:10.2307/747928.

Bowker, Geoffrey C., Timmermans, Stefan, Clarke, Adele E., & Balka, Ellen (eds.) (2015). Boundary Objects and Beyond. Working with Leigh Star, 3-35. London: MIT University Press.

Brooke, Lusk (2010). Digital Natives and Social Media Behaviors: An Overview. Prevention Researcher, 17 (5), pp. 3-6.

Cairo, Alberto (2012). The functional Art: An Introduction to Information Graphics and Visualization. San Francisco: New Riders.

De Houwer, Jan, Barnes-Holmes, Dermot, & Moors, Agnes (2013). What is learning? On the nature and merits of a functional definition of learning. Psychonomic Bulletin Review, DOI 10.3758/s13423-013-0386-3. Retrieved [2019/01/10] from: https://ppw.kuleuven.be/okp/_pdf/DeHouwer2013WILOT.pdf

Dick, Murray (2020). The Infographic. A History of Data Graphics in News and Communications. Cambridge, Massachusetts: The MIT Press.

Engeström, Yrjö, Kajamaa, Anu, Lahtinen, P., & Sannino, Annalisa (2015) Toward a Grammar of Collaboration, Mind, Culture, and Activity, 22:2, 92-111, DOI: 10.1080/10749039.2015.1024326

European Commission, Directorate-General of Communications Networks, Content & Technology (2018). Increase in gender gap in the digital sector - Study on Women in the Digital Age. DOI 10.2759/526938

Evans, Vyvyan (2015). #Language: evolution in the digital age. In: The Guardian, 2015-06-26, Retrieved [2018/08/10] from:https://www.theguardian.com/media-network/2015/jun/26/hashtag-language-evolution-digital-age

Ferrer-i-Cancho, Ramon, Hernández-Fernández, Antoni, Lusseau, David, Agoramoorthy, Govindasamy, Hsu, Minna J., & Semple, Stuart (2013). Compression as a Universal Principle of Animal Behavior. Cognitive Science, 37, pp. 1565–1578. doi:10.1111/cogs.12061

Garrido Lora, Manuel, Busquet Duran, Jordi, & Munté-Ramos, Rosa-Àuria (2014). De las TICs a las TRICs. Estudios sobre el uso de las TICs y la brecha digital entre adultos y adolescentes. IV Congreso Internacional Asociación Española de Investigación de la Comunicación. Bilbao.

González Torre, Iván, Luque, Bartolo, Lacasa, Lucas, Luque, Jordi, & Hernández-Fernández, Antoni (2017). Emergence of linguistic laws in human voice. Scientific Reports 7, 43862 (2017). doi:10.1038/srep43862

Groccia, James E., & Buskist, William. (2011). Need for Evidence-Based Teaching, New directions for teaching and learning, 128, pp.5-10. DOI: 10.1002/tl.463

Han, Kyungsik; Lee, Sanghack, Yea Jang, Jin, Jung, Yong, & Lee, Dongwon (2016). "Teens are from Mars, Adults are from Venus": Analyzing and Predicting Age Groups with Behavioral Characteristics in Instagram. WebSci '16, May 22-25, 2016, pp. 35-44. Hannover, Germany. DOI: 10.1145/2908131.2908160

Horn, Robert E. (1998). Mapping Hypertext: Analysis, Linkage and Display of Knowledge for the Next Generation of On-Line Text and Graphics. Waltham, MA: Information Mapping.

Jones, Catherine M., & Healy, Susan D. (2006). Differences in cue use and spatial memory in men and women. Proceedings of the Royal Society B: Biological Sciences, 273: 2241–2247. doi: 0.1098/rspb.2006.3572.

Kersey, Alyssa J., Braham, Emily J., Csumitta, Kelsey D., Libertus, Melissa E., & Cantlon, Jessica F. (2018). No intrinsic gender differences in children's earliest numerical abilities. Science of Learning (2018)3: 12. doi:10.1038/s41539-018-0028-7

Kirschner, Paul A. & De Bruyckere, Pedro (2017). The myths of the digital native and the multitasker. Teaching and Teacher Education, 67, pp.135-142.

Krinsky, John, & Crossley, Nick (2014). Social movements and social networks: Introduction. Social Movement Studies, 13(1), 1–21. doi:10.1080/14742837.2013.862787

Kumpulainen, Kristiina, & Erstad, Ola (2016). (Re) Searching learning across contexts: Conceptual, methodological and empirical explorations. International Journal of Educational Research, 84, pp. 55-57. doi: 10.1016/j.ijer.2016.08.004.

Kumpulainen, Kristiina, & Sefton-Green, Julian (2014). What is connected learning and how to research it?, International Journal of Learning and Media, 4 (2), pp. 7-18. doi: 10.1162/IJLM_a_00091

Lemos, Monica F., & Cunha, Fernando Rezende Da Junior (2018). Facebook in Brazilian Schools: Mobilizing to Fight Back. Mind, Culture, and Activity, 25:1, 53-67. doi: 10.1080/10749039.2017.1379823

Levin, Joel R., & Divine-Hawkins, Patricia (1974).

Visual Imagery as a Prose-Learning Process. Journal of Reading Behavior, VI(1), 23-30.

Levin, Joel R. (1989). A Transfer of Appropriate Processing Perspective of Pictures in Prose. In: H.Mandl & J.R. Levin (eds.). Knowledge Acquisition from Text and Prose. Amsterdam: Elsevier Science Publishers.

Li, Rena (2014). Why women see differently from the way men see? A review of sex differences in cognition and sports. Journal of Sport and Health Science 3(3): 155-162. (2014). doi: 10.1016/j.jshs.2014.03.012.

Linne, Joaquín (2014). Dos generaciones de nativos digitales. Intercom – RBCC. São Paulo, 37(2): 203-221. DOI 10.1590/1809-5844 20149.

Milovanovic, Dragana, & Ivanisevic, Leo (2014). Infographics as a marketing communication tool. Symorg 2014. New Business Models and Sustainable Competition Symposium Proceedings, pp. 266-273.

Molitor, Sylvie, Ballstaedt, Steffen-Peter, & Mandl, Heinz (1989). Problems in Knowledge Acquisition from Text and Pictures. In Mandl, H. &Levin, J. R. (eds.). Knowledge Acquisition from text and Pictures, 3-35. Advances in Psychology, 58. Amsterdam, New York, Oxford, Tokyo: Elservier Science Publishers.

Morera-Vidal, Francesc (2017). Aproximación a la infografía como comunicación efectiva. (Doctoral dissertation, in Spanish). Retrieved [2018/08/10] from: http://hdl.handle.net/10803/457366

Morera-Vidal, Francesc (2018). La infografía: un lenguaje multimedia adecuado a las nuevas narrativas. En: Valero Sancho, J. L. (dir.). (2018). Nuevas narrativas visuales / Novas narrativas visuais. (Colección CAC núm. 150). La Laguna: Sociedad Latina de Comunicación Social. Pág. 111-136. DOI: http://dx.doi.org/10.4185/cac150

Nikolov Dimitar, Oliveira Diego F.M., Flammini Alessandro, & Menczer, Filippo (2015). Measuring online social bubbles. Peer J Computer Science 1:e38. doi: 10.7717/peerj-cs.38

Ozdaml, Felize, Kocakoyun, Senay, Sahin, Turker, & Akdag, Sahin (2016). Statistical reasoning of impact of infographics on education. Procedia Computer Science, 102, pp. 370–377. doi:10.1016/j.procs.2016.09.414

PISA (2015). Results in focus. OECD. Retrieved [2018/08/24] from: http://www.oecd.org/pisa/

Prensky, Marc (2001). Digital Natives, Digital Immigrants (Part 1). On the Horizon (MCB University Press, 9(5): 1-6. doi: 10.1108/10748120110424816.

Rosell-Aguilar, Fernando (2018). Twitter as a formal and informal language learning tool: from potential to evidence. In F. Rosell-Aguilar, T. Beaven, & M. Fuertes Gutiérrez (Eds), Innovative language teaching and learning at university: integrating informal learning into formal language education (pp. 99-106). Research-publishing.net. https://doi.org/10.14705/rpnet.2018.22.780

Savage-McGlynn, Emily (2012). Sex differences in intelligence in younger and older participants of the Raven's Standard Progressive Matrices Plus. Personality and Individual Differences 53: 137–141. doi:10.1016/j.paid.2011.06.013

Scolari, Carlos Alberto (2018).Alfabetismo Transmedia en la nueva ecología de los medios. Libroblanco. TRANSLITERACY – 645238. H2020 Research and Innovationactions. Retrieved [2018/08/24] from: https://repositori.upf.edu/bitstream/handle/10230/33910/Scolari_TL_whit_es.pdf?sequence=2&isAllowed=y

Shaqiri, Albulena, Brand, Andreas, Roinishvili, Maya, Kunchulia, Marina, Chkonia, Eka, Pilz, Karin, Grzeczkowski, Lukasz, Mohr, Christine, & Herzog, Michael H. (2018). Sex-related differences in vision are heterogeneous. Scientific Reports, 8:7521, DOI: 10.1038/s41598-018-25298-8

Sharpe, Rhona, Beetham, Helen, & De Freitas, Sara (2010). Rethinking learning for a digital age. How learners are shaping their own experiences. New York: Routledge.

Siricharoen, Waralak Vongdoiwang (2013). Infographics: The New Communication Tools in Digital Age. The International Conference on E-Technologies and Business on the Web (EBW2013). Bangkok, Thailand, pp. 169-174.

Star, Susan Leigh (2010). This is not a boundary object: Reflections on the origin of a concept. Science, Technology, & Human Values, 35, 601–617. doi:10.1177/0162243910377624

Star, Susan Leigh, & Griesemer, James R. (1989). Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. Social Studies of Science, 19 (3), pp. 387-420.

Tascón, Mario, & Abad, Mar (2011). Twittergrafía: el arte de la nueva escritura. Madrid: Catarata.

Taylor, Paul A., & Harris, Jan Ll. (2008). Critical Theories of Mass Media: Then and Now. New York: McGraw-Hill.

Timmermans, Stefan (2015). Introduction: Working with Leigh Star. In Geoffrey C. Bowker, Stefan Timmermans, Adele E. Clarke and Ellen Balka (eds.). Boundary Objects and Beyond. Working with Leigh Star, 3-35. London: MIT University Press.

RSCH grafica documents de disseny gràfic
documentos de diseño gráfico
journal of graphic design

Tkalac Verčič, Ana & Verčič, Dejan (2013). Digital natives and social media. Public Relations Review 39(5):600–602. DOI: 10.1016/j.pubrev.2013.08.008

Toivainena, Teemu, Papageorgioub, Kostas A., Tostoc, Maria G., & Kovas, Yulia (2017). Sex differences in non-verbal and verbal abilities in childhood and adolescence. Intelligence 64: 81–88. doi: 10.1016/j.intell.2017.07.007

Valero Sancho, José Luis (2001). La infografía. Técnicas, análisis y usos periodísticos. Barcelona: Ediciones de la UAB, UPF, UV y Jaume I.

Valero Sancho, José Luis (2012). La síntesis infodigital: El cambio en la comunicación local. Zer. Revista de estudios de comunicación. 17(33): 209-226. Retrieved [2018/08/10] from: http://www.ehu.eus/ojs/index.php/Zer/article/view/10631/9869

Valero Sancho, José Luis (2017). A utilizaçao da infografia em Ambientes Educativos e de apredizagem. Presentation in XVI Congresso Internacional ErgoDesign & USICH e CINAHPA, June 2017, Florianópolis, Brasil.

Vygotsky, Lev Semiónovich (1962). Thought and language. Cambridge MA: MIT Press.

Vygotsky, Lev Semiónovich (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Vygotsky, Lev Semiónovich, & Luria, A.lexander R. (1994). Tool and symbol in child development. In R. Van Der Veer & J. Valsiner (Eds.), The Vygotsky reader (pp. 99–174). Oxford, UK: Blackwell.

Ware, Colin (2008). Visual Thinking for design. Waltham, MA: Morgan Kaufmann.

Wileman, Ralph E. (1993). Visual Communicating. Englewood Cliffs, New Jersey: Educational Technology Publications.

Wimmer, Roger D., & Dominick, J.R. (1996). La investigación científica de los medios de comunicación. Barcelona: Bosch.

Ziefle, Marina (1998).

Suplementary information: Experimental methods in pre-post test study

The surveys in pre-post test study are the following:

Survey #000: brief explanation of the questionnaire and identification of the general data of the subjects (age, gender, place of residence, level of studies and previous experience in this kind of topics)

Survey #001: (Pre-test) test of ten questions about "Global warming" with four possible answers closed and a single valid correct answer.

Survey #002: Infographics with 4 screens with information about "Global warming".

Survey #003: 1 screen with text (the same as in the infographics) about "Global warming".

Survey #004: (Post-test) Final test with the same questions as in the Survey #001.

The questions (both in pre-test and post-test) and possible answers (in bold those considered correct) are summarized in table 1.

In questions that could be answered using a Likert scale of 4 responses (odd questions, Q1, Q3, Q5, Q7, Q9) and in questions with a specific correct answer (even questions, Q2, Q4, Q6, Q8, Q10), it was possible to evaluate the evolution in men and women in stating the correct answer in both groups and according to age. Tables 3a and 3b shows the evolution of these answers of young users and one way ANOVA test. As can be seen in Tables 3a and 3b, in addition to the early abandonment mentioned above there is another set of the sample who does not respond to the post-test. This abandonment of the post-test is statistically more common among users (young and old) who do not answer the pre-test questions correctly.

Questions

Q1: What is your vision statement about 'The sea level rises due to global warming'?
Q2: Where do you think the sea level rise is more pronounced?
Q3: What is your vision statement about 'The sea level has risen 8" (20 cm) in the last 50 years'?
Q4: Since 1972, sea level rise is due mainly to:
Q5: What is your vision statement about 'The sea level rise has to do with global warming'?
Q6: In the near future, how much do you think can increase sea level?
Q7: What is your vision statement about 'The sea level rise has to do with the emissions of heat-trapping gases'?
Q8: Would you say: 'The more heat-trapping gases emissions, faster is the rise in sea level'?
Q9: What is your vision statement about 'If cease emissions of heat-trapping gases immediately sea level would remain stable'?
Q10: Since 1880, how much believe that, on average, has increased sea level?

Answers

- Q1: "Strongly Disagree", "Disagree", **"Agree"&"Strongly Agree"**
- Q2: "California", **"Florida"**, "Worldwide" & "No sea level rise"
- Q3: "Strongly Disagree", "Disagree", **"Agree"&"Strongly Agree"**
- Q4: **"Smelting of land ice"**, "Warming seas" & "No sea level rise"
- Q5: "Strongly Disagree", "Disagree", **"Agree"&"Strongly Agree"**
- Q6: **"6" (15cm)"**, **"16" (41cm)"**, "24" (61cm)" & "No estimation"
- Q7: "Strongly Disagree", "Disagree", **"Agree"&"Strongly Agree"**
- Q8: **"Not"**, "Yes" & "No sea level rise"
- Q9: "Strongly Disagree", "Disagree", **"Agree"** & **"Strongly Agree"**
- Q10: "1" (2,54cm)", **"8" (20cm)"**, "20" (51cm)" & "No sea level rise"

Table 1. Questions and possible answers (in bold correct answers) in pre-test and post-test about "Global warming".

Group	No continue		Infographics		Text (control)	
Age	Percent	Count	Percent	Count	Percent	Count
No age informed	-	-	1.0%	(n=2)	2.1%	(n=2)
10 to 30 years	62.9%	(n=68)	57.5%	(n=115)	45.2%	(n=43)
31 to 50 years	27.7%	(n=30)	33.5%	(n=67)	37.8%	(n=36)
51 to 70 years	9.2%	(n=10)	6.5%	(n=13)	13.6%	(n=13)
More than 70 years	-	-	1.5%	(n=3)	1.0%	(n=1)
TOTAL (N=403)	100.0%	(n=108)	100.0%	(n=200)	100.0%	(n=95)

Table 2. Age distribution of the study groups: experimental group (Infographics), control group (Text) and group that left the study before its completion (No continue). The Chi-square statistical test informs that there are no differences between these three groups (no continue, infographics and text) with respect to age ($p = 0.012$). Therefore, age has not been a crucial factor for the initial abandonment of the study.

RSCH grafica
documents de disseny gràfic
documentos de diseño gráfico
journal of graphic design

	Experimental Group (INFOGRAPHICS)				
PRE-TEST	**Q1 pre**	**Q3 pre**	**Q5 pre**	**Q7 pre**	**Q9 pre**
StronglyDisagree	3	3	3	2	6
Disagree	6	11	3	12	55
Agree	75	80	65	71	45
StronglyAgree	31	19	44	29	9
Total	115	113	115	114	115
POST-TEST	**Q1 post**	**Q3 post**	**Q5 post**	**Q7 post**	**Q9 post**
StronglyDisagree	0	2	0	0	7
Disagree	4	10	4	10	29
Agree	42	37	33	33	40
StronglyAgree	52	49	60	53	21
Total	98	98	97	96	97

	Control Group (TEXT)				
PRE-TEST	**Q1 pre**	**Q3 pre**	**Q5 pre**	**Q7 pre**	**Q9 pre**
StronglyDisagree	0	0	0	0	2
Disagree	1	6	1	2	27
Agree	24	27	22	28	13
StronglyAgree	18	10	20	13	1
Total	43	43	43	43	43
POST-TEST	**Q1 post**	**Q3 post**	**Q5 post**	**Q7 post**	**Q9 post**
StronglyDisagree	0	0	0	0	3
Disagree	0	4	2	1	15
Agree	22	23	21	21	12
StronglyAgree	14	9	13	14	6
Total	36	36	36	36	36

ANOVA between groups (PRETEST)	Df	Sum Square	Mean Square	F-value	Pr(>F)
Group	1	1.0	1.0061	2.013	0.156
Residuals	786	392.8	0.4997		

ANOVA between groups (POST-TEST)	Df	Sum Square	Mean Square	F-value	Pr(>F)
Group	1	4.0	3.961	7.287	0.007**
Residuals	664	361	0.544		

Table 3a. Summary of pre-test and post-test responses to the odd questions (Likert Scale) of the two groups analyzed (experimental group -infographics- and control group -text-) for young users. The ANOVA test shows that while there are no significant differences between groups in the pre-test (Df = 1, Sum Sq.= 1.0, Mean Sq.=1.0061, F=2.013, p=0.156), there are in the post-test (Df = 1, Sum Sq.= 4.0, Mean Sq.=3.961, F=7.287, p=0.007**), so that the group to which the infographic is applied significantly improves the results, which is not the case in the control group that only received texts as learning material. The tests were carried out with the R *sjstats* package (Lüdecke, 2021).

Experimental Group (INFOGRAPHICS)						
PRE-TEST	**Q2 pre**	**Q4 pre**	**Q6 pre**	**Q8 pre**	**Q10 pre**	**TOTAL**
Correct	31	84	45	22	65	247
Incorrect	84	31	70	92	50	327
Total	115	115	115	114	115	574
POST-TEST	**Q2 post**	**Q4 post**	**Q6 post**	**Q8 post**	**Q10 post**	**TOTAL**
Correct	58	74	46	11	73	262
Incorrect	40	24	51	85	24	224
Total	98	98	97	96	97	486

Control Group (TEXT)						
PRE-TEST	**Q2 pre**	**Q4 pre**	**Q6 pre**	**Q8 pre**	**Q10 pre**	**TOTAL**
Correct	9	31	17	5	20	82
Incorrect	34	12	26	38	23	133
Total	43	43	43	43	43	215
POST-TEST	**Q2 post**	**Q4 post**	**Q6 post**	**Q8 post**	**Q10 post**	**TOTAL**
Correct	13	27	16	1	23	80
Incorrect	23	9	20	35	13	100
Total	36	36	36	36	36	180

ANOVA between groups (PRETEST)	Df	Sum Square	Mean Square	F-value	Pr(>F)
Group	1	0.37	0.3743	1.539	0.215
Residuals	786	191.44	0.2433		

ANOVA between groups (POST-TEST)	Df	Sum Square	Mean Square	F-value	Pr(>F)
Group	1	1.18	1.1767	4.73	0.03*
Residuals	664	165.2	0.2488		

Table 3b. Summary of pre-test and post-test responses to the even questions of the two groups analyzed (experimental group -infographics- and control group -text-) for young users. The ANOVA test shows again that while there are no significant differences between groups in the pre-test (Df = 1, Sum Sq.= 0.37, Mean Sq.=0.3743, F=1.539, p=0.215), there are in the post-test (Df = 1, Sum Sq.= 1.18, Mean Sq.=1.1767, F=4.73, p=0.03*), so that the group to which the infographic is applied significantly improves the results, which is not the case in the control group that only received texts as learning material. The tests were carried out with the R *sjstats* package (Lüdecke, 2021).

RSCH grafica
documents de disseny gràfic
documentos de diseño gráfico
journal of graphic design

If we analyze comparatively the evolution of correct answers according to age (table 4), then we can see how infographics significantly improve the correct answers in all participants with respect to the text. The improvement is statistically better in the older participants due in part to a greater abandonment of these users who had given erroneous answers in the pre-test. Young people leave less post-test despite responding incorrectly at the beginning.

Group	TEST	Correct	Incorrect	CMH Test	
CONTROL (TEXT)	PRETEST	82	133	chi-square:	1,356
young	POST TEST	80	100	d.f.:	1
				P-value:	0,244
Infographics	PRETEST	247	327	chi-square:	12,033
young	POST TEST	262	224	d.f.:	1
				P-value:	**0,0005**
CONTROL (TEXT)	PRETEST	108	146	chi-square:	3,684
old	POST TEST	108	100	d.f.:	1
				P-value:	0,055
Infographics	PRETEST	165	251	chi-square:	27,935
old	POST TEST	188	127	d.f.:	1
				P-value:	**1,25407E-07**

Table 4. Summary of the evolution of the total of correct answers (pre-test and post-test) in the young users (under 30 years old) and in the older ones. The results are significant according to the CMH test for the experimental group (infographics) regardless of age.

On the other hand, if we analyze the behavior by gender, infographics works better in men, especially in the older ones, than in women. In fact, without falling into the Simpson's paradox, the CMH test indicates that older men are the only subgroup that makes globally the results of infographics significantly better than in the control group, in the questions in which there is a correct answer (Table 5). In the other subgroups the results are not statistically significant, following CMH Test (Table 5).

Infographics GENDER	**TEST**	**Correct**	**Incorrect**	**CMH Test**	
Old Woman	PRETEST	92	96	chi-square:	2,761
	POST TEST	90	49	d.f.:	1
				P-value:	0,0965
Old men	**PRETEST**	**95**	**123**	**chi-square:**	**5,305**
	POST TEST	**106**	**65**	**d.f.:**	**1**
				P-value:	**0,0212**
Young Woman	PRETEST	145	185	chi-square:	2,83
	POST TEST	145	124	d.f.:	1
				P-value:	0,093
Young Men	PRETEST	102	143	chi-square:	1,1100
	POST TEST	117	120	d.f.:	1
				P-value:	0,2920
TEXT GENDER	**TEST**	**Correct**	**Incorrect**	**CMH Test**	
Old Woman	PRETEST	59	75	chi-square:	0,3471
	POST TEST	57	51	d.f.:	1
				P-value:	0,5557
Old men	PRETEST	49	70	chi-square:	0,3809
	POST TEST	51	49	d.f.:	1
				P-value:	0,5371
Young Woman	PRETEST	46	89	chi-square:	0,0062
	POST TEST	46	89	d.f.:	1
				P-value:	0,9372
Young Men	PRETEST	36	44	chi-square:	0,0099
	POST TEST	34	46	d.f.:	1
				P-value:	0,9205

Table 5. Summary of the evolution of the total of correct answers (pre-test and post-test) in the young users (under 30 years old) and in the older ones, in the control group (text) and the experimental group (infographics). In this analysis of subgroups by gender, the group of older men is the only one in which a significant improvement is observed according to the CMH Test.