

The comics as a tool to inform scientific concepts about glass in an interesting and playful way

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Introduction

Comics, defined as “sequential art” (Eisner, 1989) are a popular medium, constituted of the union between text and image. Another definition tells that comics are “pictorial and other juxtaposed images in deliberate sequence” (Mc Cloud, 1995, p. 9). Comics tell fantastic stories, dramas of everyday life, humorous stories, great adventures, romantic tales, have worlds where can be real or imaginary and characters which the reader can relate or hate. In other words, reading a comic is a journey to meeting new universes, created by the comics author. The comics topics and themes are vast and unlimited: they can deal with issues as love, friendship, effort; and about an specific theme such as sports, food, everyday life, fantastic worlds; they also can be used for addressing social issues and recent topics. And for communicating science in a informative and playful way.

According to Vergueiro (2014), we can found two types of languages in comics: the visual language, comprised by the drawings of the characters, scenery and how they are arranged in each frame and the textual language, that is the textual element of the comics such as character dialogues, subtitles and the onomatopoeia (the “sound” used in comics).

Comics are a interesting tool for science communication because we can use its principal feature, the simultaneous use of text and image, for communicating science. The scientific concept can be explained by the drawings, helping the reader to understand the information and the text used can be divided by various speech balloons so that the reading become more fluid. Navarro (2013) talks about the use of images in the learning process and mentions its function in the understanding of texts, seen in the comics.

Other positive factors about the use of comics for science communication are the fact the comics are an accessible media and popular worldwide. Comics can be purchased from comic book shops, bookstores, from the internet and are a wide range of comics available from the internet – also called webcomics, which can be read for free or purchased. Despite the fact that people thinks it is a media only directed for children and/or teenagers, many people read comics. You can find comics directed to the adult public, such as *Maus*, by Art Spiegelman (2005) and *Ayako*, by Osamu Tezuka (2018). It is possible to talk about any scientific content in comics without losing the scientific formalism, since it is suitable for the public intended. Also, as stated by Farinella (2018), “one of the main benefits of comics in science communication could be the mapping of abstract scientific concepts on to everyday objects and experiences, helping the public to engage with the material at a more personal level” (FARINELLA, 2018, p. 8).

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We can define comics that explain or inform about a scientific topic, as “science comics”. A definition for this term asserts that science comics are

“(…) comics which have as one of their main aims to communicate science or to educate the reader about some non-fictional, scientific concept or theme, even if this means using fictional techniques and narratives to convey the non-fictional information.” (TATALOVIC, 2009, p. 4)

In other words, this material concerns about accurate scientific information, differently from fictional comics. This genre of comics also helps to promote science to the general public, making it easier to understand.

The practice of science communication also may concern how this communication of science is held, proposing adequate methodologies for this objective, and the comics is one of them. Science communication is related with the objectives and the type of public, that can be distinct, as stated by Albagli (1996): they can be related to educational issues, be concerned about the public opinion in science-related topics, or as a form of popular mobilization.

Thinking in science communication as a form to inform about science to the public using adequate methods for this objective, or in a more complete definition:

“Science communication (SciCom) may be defined as the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science (the vowel analogy): (A) Awareness, including familiarity with new aspects of science; (E) Enjoyment or other affective responses, e.g. appreciating science as entertainment or art; (I) Interest, as evidenced by voluntary involvement with science or its communication; (O) Opinions, the forming, reforming or confirming of science-related attitudes; (U) Understanding of science its contents, processes, and social factors.”(BURNS et al., 2003, p. 191)

A partnership between Center for Research, Technology and Education in Vitreous Materials (CeRTEV) and Nucleus Ouroboros of Science Communication was established and the comic series called “Glass Comics” was created. It is about glass research, history and curiosities. This topic was chosen because glass is presented in many objects, such as household items, decoration, in communication, vehicles, buildings, medical equipment and others. In other words, glass is part of everyday life of people and it is an interesting subject to be handled in science communication. The research and curiosities related to glass can motivate and arouse interest of the public.

Materials and method

The production of the “Glass comics” series started in 2014, and the print version was produced in 2015. The time of production of each number is approximately 3 months. It was planned to be five numbers at all, and four numbers are already finalized and available for print version and online reading at the CeRTEV website: <http://www.vidro.ufscar.br>, in Portuguese.

Table 1 presents a summary for the production of a comic number:

STEP	DESCRIPTION
Script writing	Writing of the script for the comic and search of the scientific topics.
<i>Storyboard</i>	Draft of the comic pages, based on the script scenes and dialogues.
Drawing of pages	Pages are drawn and the text of the comic is inserted.
Review	Grammatical review of the text and its scientific contents.
Printing and publication	The comic is printed and also be available for digital format in the website < http://www.vidro.ufscar.br/ >.

Tab. 1: Production steps of a number of “Glass Comics”.

Each number talks about a different topic in the glass universe and consists in a complete story, so the reader can choose any number in a different order and understand the story. The scientific consulting with different CeRTEV researchers is made for each number. At the end of the number 2 there is an activity section with crosswords, seven errors game and others. Each printed number has 20 pages and A5 size (148 mm x 210 mm). The drawing style used was inspired in Japanese comics, also called “manga”. Despite this, the reading format is from left to right, as an occidental way. The cover is colored, but inside the drawings can be painted by the readers.

The language of the comics intends for aim children from 12 years old and teenagers because the main characters are children, so they can relate with them. The scientific explanation of the comics is presented in a informative way, in the format of curiosities and short explanations. They differ from technical books or educational books because the objective with this material is motivate the interest about glass and science in general. Also, the construction of the script considered the public intended, so the children characters talks in a informal way and makes some jokes in the comic to bring humor, making the reading more fun.

The choice of each theme considered what topics in the glass universe are present in the everyday life of the people, but at the same time, inform about the research in the CeRTEV and its technological applications. For this purpose, these themes were selected: definition, history and applications of glass (number 1), recycling and production of glass (number 2), optical fiber and research/applications (number 3), bioglass and research/applications (number 4) and the glass era, about how the glass was present in different historical periods (number 5).

Results and discussion

Comics production

The Glass Comics presents three main characters: Vinicius, the protagonist, is a smart and curious boy who likes to play games; Mateus, his elder brother and researcher of CeRTEV, responsible for explaining the scientific concepts presented in the comic and Luisa, Vinicius's friend, also an intelligent girl who likes to tease him. Figure 1 shows the covers of the printed version from numbers 1 to 4:

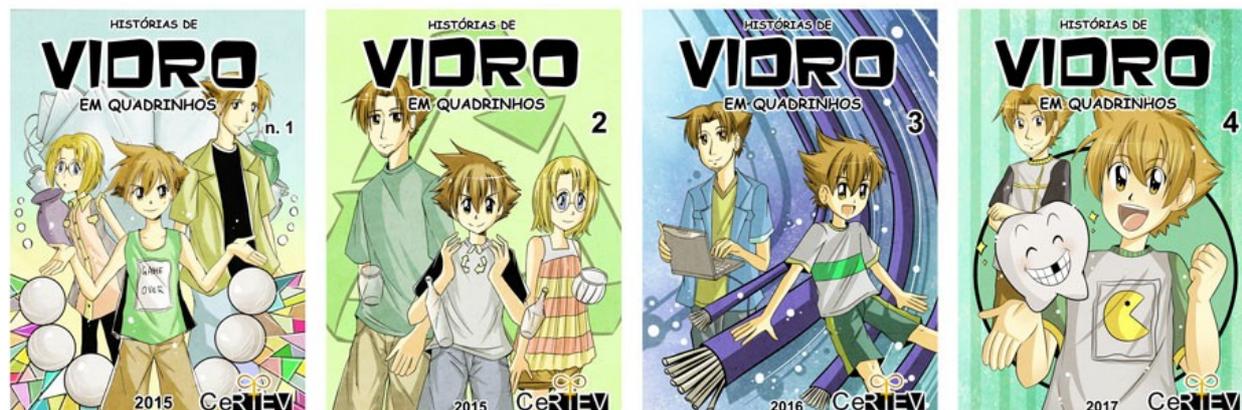


Fig. 1: Cover of numbers 1 to 4 of “Glass Comics”.

The number 1 of “Glass Comics” talks about the definition, history and applications of glass. The story begins with Vinicius and Luisa with difficulties to think about a topic for a homework about materials, and Mateus suggests the glass theme. Vinicius is reluctant in the beginning but his brother explains the different definition of glass, the mystery about the discovering and shows some curiosities of this material, e.g. the natural glass – obsidian and the color of the glass pots (Fig. 2), due to the presence of chemical elements in the composition.

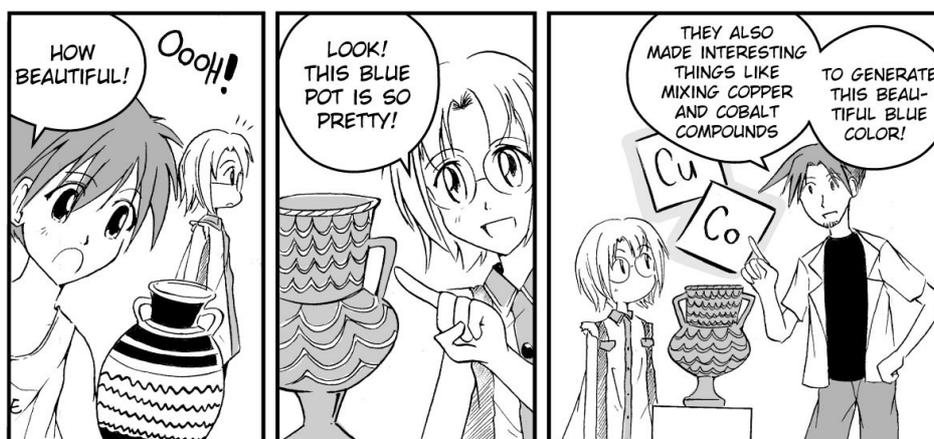


Fig. 2: Explanation about the composition of Egyptian blue glass pots, which contained copper and cobalt in its composition.

Next, Mateus talks about the technological applications of glass, such as laminated glass, used as security glass, mirror glass, presents in the building windows, the tempered glass, a more resistant type of glass and the vitro ceramic, used in modern stoves. In the end, the children decided to talk about glass in their homework.

The number two is about recycling of glass and begins with the 3 characters organizing the garage. Vinicius finds a box full of glass bottles and ask Mateus if he is going to throw away. Mateus explains the correct is to recycle the glass, and talks about some curiosities, such as the fact of the glass is 100% recyclable, it can be reused several times. He also explains about the materials used for the production of a glass bottle. Next, Mateus takes them to a glass factory and explains the industrial production of a glass bottle. They return home and Vinicius, after

understanding the importance of recycling for nature, begins separating the glass bottles for recycling.

The number 3 of the comic is about the optical fiber. Vinicius is playing games at the computer when the internet stops working. He starts to complain about this, asking Mateus about how the internet comes to our houses. Mateus explains about the principles of optical fiber (Fig. 3) and how they conduct data information using light, the same process is applied in the transport of data from the internet. He explains about the advantages of the optical fiber usage, such as material type, and mentions other research using other optical glasses that they conduct at CeRTEV.

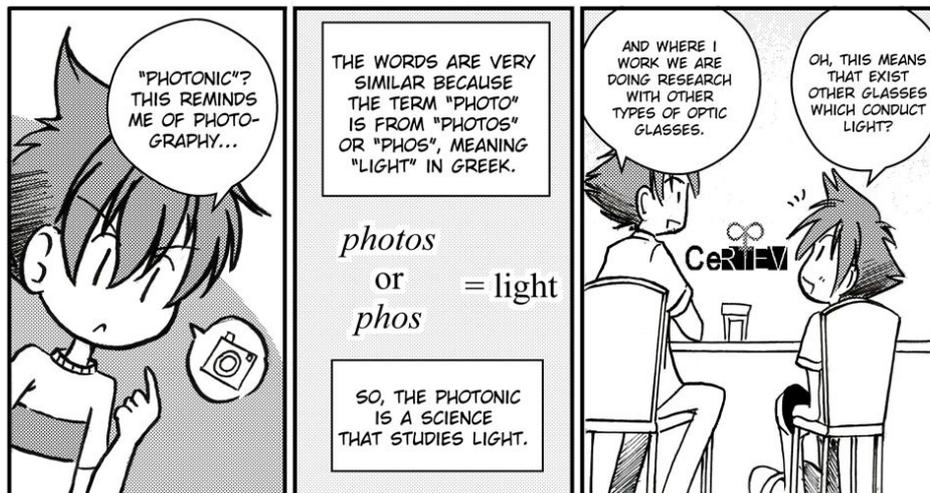


Fig. 3: Explanation about the origin of term "photonic".

Mateus mentions about some optical fiber applications in the medical field and communication. At the end of the story they are going to buy a gift for Luisa's birthday, and Mateus suggests an optical fiber bedside lamp.

The fourth and last number produced until now is about the bioglass and its main applications. It begins with Vinicius playing games at the sofa when his mother asks him to leave for cleaning. He is so concentrating in playing that he does not realize the glass door in front of him and ends hitting hard, breaking his front tooth. Mateus takes him to the dentist and he explains about the bioglass, a synthetic material able to form a chemical bond with the bone. Later, he explains about the discovery of bioglass, due to the research work of Larry Hench and the research at CeRTEV using bioglass material. At the end, Vinicius was scolded by his mother who asked him to clean the glass door.

The number 5 will illustrate a theater play of Nucleus Ouroboros named The Glass Era that presents the glass in different eras, since the Stone Age, passing through the Medieval and Modern Ages until Contemporaneity, with the main discoveries about this material.

Comics Activities

Some activities using the comics were proposed to the general or academic publics and divided in two categories that are listed as follows:

- a) Reading and analysis

The comic was distributed in science communication events and conferences for reading and posterior analysis using a questionnaire. The comics were read by a group of middle and high school students (n= 30) at the Science Circus event, and distributed for the general public (n= 1000) at the Society for the Progress of Science event, both in São Carlos-SP. The comics also were read at "JALEQUIM- National Meeting of Games and Playful Activities in Chemistry Teaching by a group of undergraduate, graduate students and teachers in Goiania-GO (n= 20) and finally read by the participants (n= 14) of a course held at "CDCC (Center for Science Communication and Culture of USP São Carlos), from University of São Paulo, campus São Carlos.

The questionnaire has comprised questions about the effectiveness of comics in science communication and the reader feelings about the comic, such as sympathy or antipathy. Most of the responses mentioned the sympathy for the comic's proposal and supports the idea that the comics can be used for science communication. The responses highlight the usefulness of the comics for teaching and education at schools and mention their informative character, while other responses mention the playful and humorous side of the comic.

Below are some of the responses obtained, from the high school students (1 and 2) and graduate students and teachers (3 and 4):

- (1): "Yes, because it shows in a simplified and playful way the process of fabrication of glass"
- (2): "Yes, because it is educational and informative, I learned things I didn't know"
- (3): "Yes, presents a lot of information about glass in a light and interesting way"
- (4): "Yes. Well contextualized and well-directed for the teenager public and students"

b) Workshops for comics production

Workshops of comics production by the public were carried out in two events involving undergraduate and graduate students. The first was Science on Stage, an annual meeting of science theater groups, mainly composed of undergraduate students, with 8 hours of activities and the second was the Workshop of Science Communication and Playful Activities with teachers from private or public systems who were students in the master's degree course at Chemistry Department of UFSCar, with 1 hour of activities. Considering the workshops duration, most of the public produced short comics called strip-comics, with topics related to glass.

One of the strip comics produced in the workshops is shown below and depicts about the glass production in the Egypt:

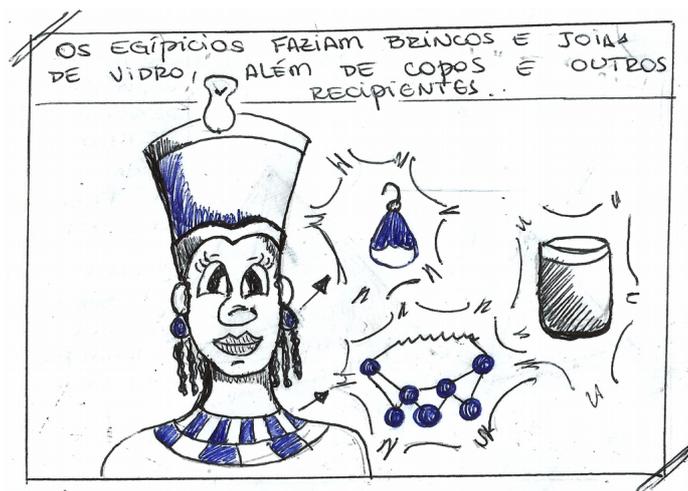


Fig. 4: Comic produced about glass production in Egypt. The text says: “Egyptians did earrings and jewels made of glass, also cup and other objects.”

Also, there was an inclusion activity with a group of blind people about the production of a comic script, based in the scientific contents of glass. The text will be the basis for comic number 5 and for the theater play: The Glass Era.

Conclusions

Science communication practices that involve the public permit a mindful construction of knowledge and a better perception of science effects at day by day life. The comics are a way to promote science in the everyday life of the people, in a way the topics and curiosities presented in the comics can motivate the public talking about glass, for example, in informal conversations. It is a very important point when talking about the science communication practices and what is the public perception and responses about the science of materials, either by reading of the comics or by the comic's production.

The comic is a potential tool for science communication, because is a media that integrates both image and text, informing the scientific concepts in a playful way. Because comics are a entertaining material and very accessible, the public, in special children and teenagers, are less reluctant in reading this type of material than a book. The public positive responses about the “Glass comics” support our arguments about the potential of comics to inform scientific topics and the workshops for comics production are an interesting way to promote public science communication, letting them developing skills such as creativity and socialization at the same time they discuss science concepts or curiosities.

Comics connect science and art, reaching a wide public in different ways, motivating and arousing the interest about scientific topics and the science itself. So, the science could be seen effectively inside people's life.

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