



INTRODUCING COMICS AS AN ALTERNATIVE SCIENTIFIC NARRATIVE IN CHEMISTRY TEACHING

^aKaren C. WEBER, ^bTeresa C. B. SALDANHA, ^cKhyslayny K. DE SOUSA E
SILVA, ^dPatricia M. M. SANTOS, ^eDirceu D. D. SOUZA & ^fAgnaldo ARROIO

^aProfessor, Departamento de Química, Universidade Federal da Paraíba, karen@quimica.ufpb.br

^bProfessor, Departamento de Química, Universidade Federal da Paraíba, teresa@quimica.ufpb.br

^cScholar of PIBID/CAPES, Departamento de Química, Universidade Federal da Paraíba, khyslayny2@hotmail.com

^d Scholar of PIBID/CAPES, Departamento de Química, Universidade Federal da Paraíba,
patriciamoura2536@hotmail.com

^eProfessor, Departamento de Química, Universidade Federal da Paraíba, baumcima@yahoo.com.br

^fProfessor, Faculdade de Educação, Universidade de São Paulo, agnaldoarroio@yahoo.com

Abstract

In this work we present an experience report involving the execution of a pedagogical workshop about comics with Chemistry teaching undergraduate students. The workshop had as main goal to promote a discussion on the potential of narratives as an alternative approach to teach Chemistry, focusing on the development of teachers' authorship of pedagogical material and at the same time on the integration of information and communication technologies (ICT) in the classroom. The report is divided in two segments: (i) the description of the workshop execution; (ii) a synthesis of the reflections collected from the participants by means of a questionnaire applied in the end of the workshop. The main results praise comics' playful character and their potential to stimulate creativity in students, as well as indicate the relevance of educational material authorship in the pedagogical practices of professors in training. Overall, the discussions performed point to the still incipient presence of ICT in the pedagogical training of Chemistry teaching degrees, which highlights the pressing need for incorporating these technologies on formative practices. Moreover, reflections on the pedagogical value of using comics as a narrative approach aiming at the development of scientific and media literacy were raised by the present work.

Keywords: comics; ICT; narratives; scientific literacy.

INTRODUCTION

Comics have been considered an important pedagogical resource in teaching education programs (Santana & Arroio, 2012). If properly explored in the classroom, comics, with its peculiar features, has an enormous power to tell stories and convey messages, contributing to stimulate students' active participation and creativity, along with oral and written language and even the development of technological abilities. They also show potential to capture and maintain students' interest, besides being considered as an intermediate support for learning difficult concepts (Yunus, Salehi & Embi, 2012).

Specifically scientific comics allow conveying science or educating readers about non fictional events, scientific concepts or issues of social interest (Tatalovic, 2009). For presenting aspects as first person writing and the report of thoughts, comics are regarded as a kind of reading that involves one more deeply into the story. Used in the context of Chemistry classes, these features can be used to positively modify the image of Chemistry among students (Maccloud, 1993; Araujo et al., 2007; Olson, 2008; Ferreira & Fraceto, 2009).

In democratic societies, the decisions on which should be the directions for science policy should include the participation of members of this society, which requires a minimum of scientific literacy by the population (Bybee, 1997, Osborne, 2007, Burden, 2007). The concept of scientific literacy has been reported in the literature as "to be able to read and write" (Miller, 1983), "to describe a desired familiarity with science by the general public" (DeBoer, 2000), "public understanding of Science" (Laugksch, 2000), "ordinary" people and scientifically trained experts effectively engage in collective public policy and decision-making on scientific issues (Roth & Barton), and, in a more expanded view of the concept, Norris & Phillips (2003) isolate the term literacy and propose that this term, in the fundamental sense, "is based upon the same epistemology that underlies science and that the reasoning required to comprehend, interpret, analyze, and criticize any text resembles in its major features the reasoning at the heart of all of Science".

Discussions about the controversies surrounding the concept of scientific literacy will probably continue, because this is a topic of enormous dynamism; however, we draw

attention to an aspect involving the role of narratives as an essential component in the process by which both teachers and students should move along during the school period towards a scientifically literate society. In another level, the production of comics with the aid of ICTs (Information and Communication Technologies) can play an important role in approximating students to topics considered difficult, especially with thematic concepts originated from scientific disciplines. Moreover, this kind of activity may contribute to the development of critical and analytical thought, which are typical of this field.

Narrative as a component of scientific literacy

The word “*narrative*” comes from Latin, with “*narro*” meaning *relate* or *tell*. As well, for Norris *et al.* (2005), narrative describes “*the desire created in readers and listeners to know what will happen*”. Taking the definition of Strube (1994) for narrative as the telling of sequential events in a way that it portrays a meaningful and coherent whole, comics can be regarded as a kind of narrative that combines words and images, resulting in a great potential to tell stories and transmit messages. However, although storytelling as a pedagogical practice has been a tradition since ancient times, stories have not played a central role in Science teaching in Western school (Tan *et al.*, 2012).

The pedagogical value of narrative in Science education relies on the fact that its structure allows concepts to be placed in a form that is easy to assimilate and can also provide elements to memorization and re-elaboration. Moreover, if a student is able to place discipline knowledge into a personal and clear narrative structure, then this knowledge can be put in other contexts that will no longer belong to such discipline, but instead will be integrated to knowledge from other disciplines. In order to do this in such a way that the narrative becomes meaningful for the narrator and readers or listeners, a process of adaptation of the language of Science to the language of the narrator has to be undertaken. This requires that the narrative must be anchored in actual Science, since the teacher (as an authority in Science) will be a reader/listener, but at the same time it has to bring student's style of written expression (Strube, 1994).

Other arguments for the use of narrative in communicating science are provided by

discursive psychology, which provides support to narrative understanding as a major meaning-making strategy (Lyle, 2000), claiming for the utilization of diversified writing-to-learn strategies in the Science classroom, which may contribute to writing-to-learn Science literature. Narratives can even be used to complement the kinds of argumentation students employ in the negotiation of socioscientific issues, promoting the development of positive attitudes toward Science and dealing with misrepresentations of it through the media, which limits understandings of the nature of science by the public (Ritchie, Tomas & Tones, 2010).

Another relevant aspect of using comics produced with the aid of computers as scientific narrative in the classroom is the opportunity to develop digital and media literacy, in the perspective of counteracting the depersonalising effects of mass technology (Tornero & Varis, 2010). This is a topic that should permeate teacher training programs, since the potential coming from the ICTs can improve access to information and quality of education (Buckingham, 2003). By perceiving themselves as authors of new pedagogical materials, it is possible to develop the values of individual autonomy based on critical thinking and the right to information, as well as personal and collective creativity and imagination as elements of a healthy communication .

According to Arroio (2011), using comics in science education based on narrative approach allow an important way in which people are step by step introduced to a scientific knowledge community by sharing a discourse in the context of relevant tasks.

METHOD

A four-hour pedagogical workshop was undertaken with a group of twelve students of an undergraduate Chemistry teaching course. The workshop began with a short lecture about the differences between literary narratives and the scientific speech usually employed in the classroom. Then, the potential of ICTs as a tool to introduce these alternative ways of narratives for conveying scientific information was discussed.

Next, students were divided in pairs to make a first contact with software MkGibi (MicroKids, 2013), exploring some of its functionalities. Then, they were oriented to produce

their own narratives in the form of comics, which were supposed to deal with chemistry-related issues from their daily lives. After finishing their productions in the computers, all stories were shared with the whole group. In the end, students' opinions on the activities performed were collected by applying the questionnaire shown in Box 1. Here is important to highlight that written opinion surveys are considered a good alternative to have feedback from students, since they assure anonymity and allow a complete analysis of students' perceptions on thematic issues, materials, processes and attitudes taking place during such kind of formative event.

Box 1. Questionnaire applied for participants of the pedagogical workshop.

Question#	Enunciation
01	In your Chemistry teaching undergraduate course, the use of comics to teach Science/Chemistry has ever been discussed? () Yes () No. If you answer yes, specify in which moment this has been done.
02	And about authorship by Chemistry teachers for production of pedagogical resources? () Yes () No. If you answer yes, specify in which moment this has been done.
03	How do you describe the present experience of producing comics? What were the easiest and the most difficult steps during this activity?
04	Do you regard comics as an useful tool for teaching chemistry? Why?
05	In your opinion, how would be high school students' reactions in a Chemistry class using comics as a pedagogical resource?
06	Which thematic issues related to Chemistry you consider more prone to be taught using comics?
07	Do you feel prepared to use this resource in a high school Chemistry classroom? Why?
08	What do you think your undergraduate course lacks in order to prepare you for the use of ICTs in Chemistry teaching?
09	Please leave some comments, suggestions or general opinions.

Furthermore, students' written productions were assumed as the materialization of authors' discursive projects (Grillo, 2012), and were assembled by their enunciations in the sense of describing and extending individual and collective comprehension, searching for meanings and sharing opinions. For that, an adaptation of written speech analysis was employed, which consists of three main steps: unification, categorization and communication (Moraes,

2003).

The report presented here is organized in two segments. In the first one, we describe how the workshop have proceeded, commenting its relevant aspects and, in the second one, we present a synthesis and discussion of the answers obtained in the questionnaires. Students' perceptions on the role of this workshop for their teaching education will be discussed, along with their forethoughts on possible impacts on high school Chemistry classes of the discussed concepts and knowledge acquired during the workshop.

FINDINGS AND DISCUSSION

The workshop begun with considerations about the use of comics as narratives to convey scientific information. The impact of conventional narratives in our daily lives was discussed, such as the ones presented in the movies, television shows or fictional books, which are able to emotionally involve the audience, influence consumption habits and propagate different ideologies. Then, reflections were made on the possibilities of broaden the use of different speech genres as tools to mediate Chemistry teaching and learning processes.

Keeping that in mind, comics were presented as an alternative speech genre for learning and information communication, since they would be properly adapted to the educational context. Several examples on the use of comics in diverse teaching experiences were presented, specially in teacher education programs, in the fields of Natural Sciences, Health and Environmental Education. At this moment, participants took notice of some computational tools available for comics production. Here is important to mention that two pivotal capabilities for teaching education were being explored: abilities to use computers in the classroom and teachers' authorship of pedagogical resources.

The next step was the practical part of the workshop, beginning with a first exploration of the software to be used for producing the comics. Participants had the opportunity to get to know all its features, checking available libraries of scenarios, characters and their facial or physical expressions, besides the specific resources of this kind of narrative (ballons expressing characters dialogs or thoughts). Knowing that they will be limited to resources

available in the software, participants were oriented to search for scenarios, characters or other elements available at the Internet, which could be inserted to help to tell their stories. After that, students were encouraged to create their own stories, which should be about the Chemistry of everyday life. Indeed, before beginning to produce the stories, they were alerted about the importance of planning in this kind of activity. Thus, before creating the comics at the computers, they produced storyboards using pencil and paper only. Then, they were able to produce their comics in the computers, meanwhile some technical difficulties or software limitations were eliminated or adapted, in such a way that they can reach the final goal of producing narratives on daily life Chemistry.

The produced narratives were mainly focused on environmental issues, such as global warming, garbage and pollution, and also on health concerns (healthy food intake and alcohol abuse), as shown in Figure 1. Additionally, it was possible to observe the presence of funny elements and cultural manifestations related to participants' lives (Brazilian Carnival, social networks and going to the beach).

Finishing this step, each pair of students shared the created stories with all participants, with the aid of a data-show. An interesting fact that occurred without asked was that students interpreted their stories as in a play, which added a playful and affective character to this moment of socialization of their productions.

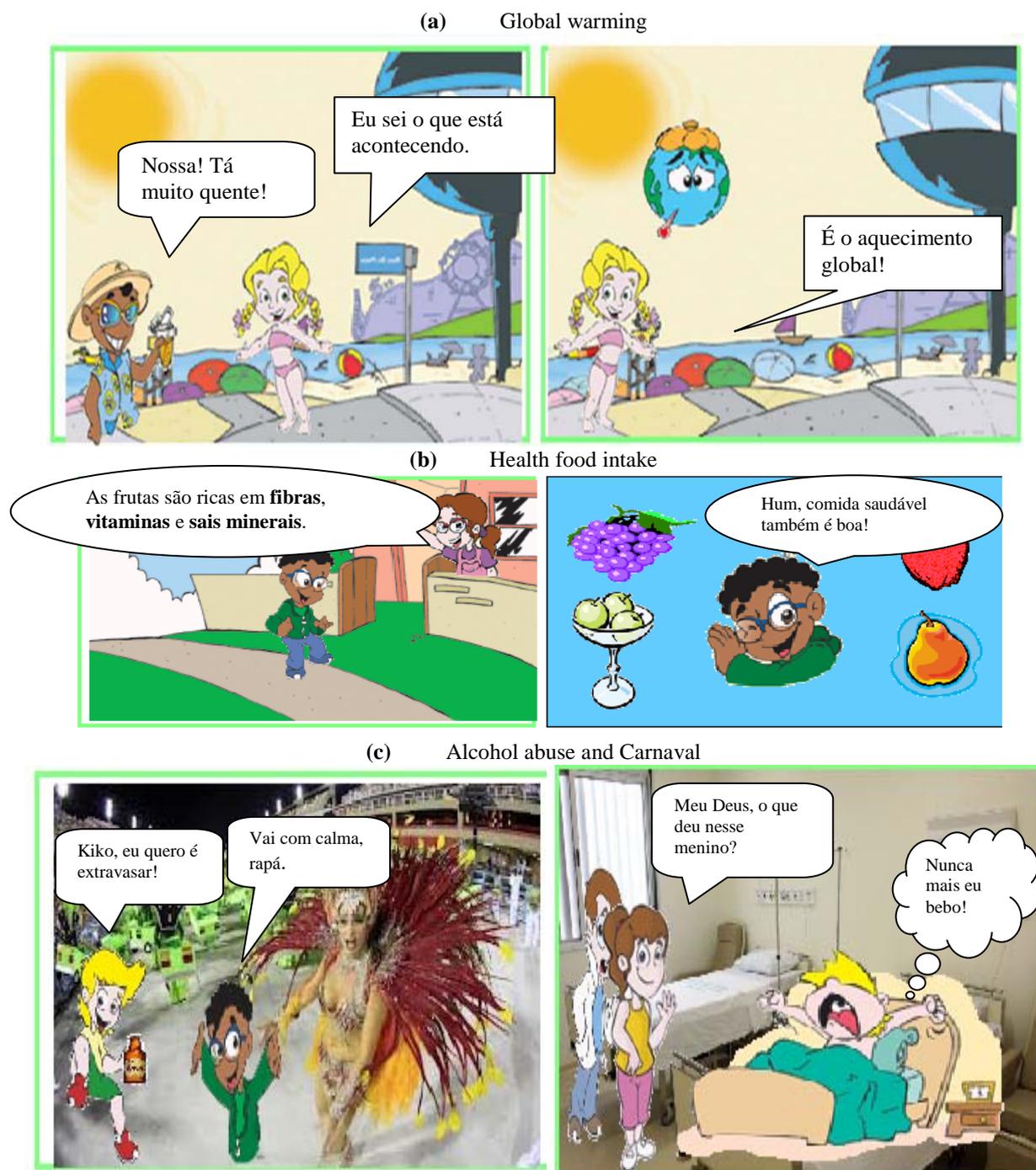


Figure 1. Stripes from some of the comics produced by students.

(a) –Uau! It's too hot! – I know what's happening. – It's the global warming!

(b) – Fruits are rich in fibers, vitamins and minerals. – Hum, healthy food is also good.

(c) – Kiko, I want to have a blast! – Take it easy, man. – My God, what is going on with this boy?
– I'll never drink again!

The compilation of textual content of the answered questionnaires revealed several aspects related to the pedagogical education they are receiving, and also lead to a reflection on the formative practices currently assumed in their teaching education. On the one hand, all students answered that they were never introduced to comics, specially associated to ICTs as possible tools to mediate Chemistry teaching-learning process. Most of them have also revealed that they envision the possibility of, as a teacher, be an author of pedagogical resources. On the other hand, only four students admitted that this issue has been addressed during their undergraduate course, in regular disciplines or as part of teaching projects they are engaged with the local community, such as the Institutional Program for Grants in Initiation to Teaching (PIBID) (Santos, Gouvêa & Arroio, 2013) , granted by Brazilian government.

Concerning the activities undertaken during the workshop, the students highlighted as more difficult the steps of defining the subject to treat in the stories, the production of the comics itself, the insertion of dialogs, and dealing with the limited resources of the software, while creating the storyboard in the paper, inserting images, and handling the software were considered the easiest tasks.

When asked about the usefulness of comics to teach Chemistry, the participants demonstrated that would use comics in their classes, since they consider it as a playful and interesting approach to discuss chemical concepts, “making Chemistry amusing”, “to teach and entertain at the same time”, and also because it can help to develop creativity and stimulates reading, getting away of traditional chalk and blackboard classes. This has been made explicit in excerpts as “...comics are an amusing and interesting way to involve students to engage in learning Chemistry...”, “... it’s an enjoyable entertainment”, “the images and dialogs, along with the creativity needed to create the stories can arouse a deep interest of students to learn”. According to Arroio (2010),

“it is therefore important to think of education systemic term, not limiting the student’s experiences to what can possibly take place in the classroom. With appropriate supporting activities, it is suggested that science teachers, trained in using this audiovisual context-based

methodology, can help reverse the negative attitudes that many students have toward real science by moving them from familiar experiences they enjoy to unfamiliar experiences they expect to be dull and difficult.”

Another important contribution is the planning, creating, imagining, executing, drawing, etc., when they are facing challenging situations related to the quotidian, as problem situations and also the search for possible solutions. The comics elaboration can contribute as well to the development of other abilities, which are really important for teacher education, such as coherence and cohesion – by a text construction; summarization and objectivity capacities by resuming a dialog in a balloon; utilization of different languages by adopting symbols, signs or images to transmit the information; development of creativity, ideas, thoughts and concepts, besides the development of reading and writing, according to Arroio (2011).

Discussing the possible impacts of this kind of activity in the classroom, participants ponder that in general students at the high school do not know this strategy to address Chemistry contents, and would probably express reactions of surprise, but in a positive way, since this would attract their attention and enhance their interest on learning, setting a better mood in the classroom. They also highlight that it is possible to teach several contents, however with different opinions about which kind of content: uppermost, students consider that is possible to deal with conceptual topics as atomic models, chemical kinetics, or chemical bonds; some of them suggested thematic approaches such as environmental questions or sustainability.

In this perspective the use of comics in chemistry classroom reveals substantial potential for scientific literacy if we consider that knowledge and understanding, including scientific understanding, are constructed when individuals engage socially in talks and activity about shared problems or tasks, meaning making is thus a dialogic process involving talks, so learning is considered as the process by which individuals are introduced to a culture by more skilled members (Drive *et al.*, 1994).

Continuing the reflections on the influence of their undergraduate education for teaching, most students indicate that do not feel prepared to use this kind of resources in the

classroom. The main reasons pointed out by them are the superficial mastery of the software and the short time they had to experience this strategy. Speaking in a more general way about the possibilities of inserting strategies mediated by ICTs in Chemistry teaching, students highlight that is necessary to increase actions such as the one experienced in this workshop, which are focused specifically to teaching practices.

CONCLUSION

This study has reported the experience undertaken by a group of undergraduate students that took part on a pedagogical workshop focused on the production of comics as a speech genre towards the discussion of Chemistry topics. The juxtaposition of the synthesis of our results, assembled from opinions issued by participants, grounded on results from empirical researches from the literature, reveal an intense closeness not only regarding students perceptions but also on forethoughts about possible impacts of using the proposed strategy in high school Chemistry classes.

This proximity of meanings constructed by participants lead us to reflections on the need to discuss alternative strategies during teaching preparation courses, since the general opinions on workshop attainment and on the issues discussed during it were extremely positive, which implicates on the importance of extending the inclusion of this kind of activities in order to complement the formative process of future Chemistry educators.

These findings suport the calls about the potential of narrative for improving science education, since it helps teachers to develop students' scientific literacy, as well as being a tool to reelaboration and renegotiation of meanings of the concepts studied. Integrating activities able to promote scientific literacy in a teacher education program is a fundamental step towards the achievement of a society in which citizens can take part as scientifically informed participants.

ACKNOWLEDGEMENTS

This work was performed with support from CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil), within the programs PIBID (Programa Institucional de Bolsa de Iniciação à Docência) and Prodocência (Programa de Consolidação das

Licenciaturas), Edital CAPES/Prodocência 028/2010. The authors also would like to acknowledge all participants of the workshop.

REFERENCES

- Araujo, K. C. M.; Sá, M.C.; Neves, M. A.; Campos, T. C.; Brito, N. M.; Amarante Júnior, O. P. (2007). *Elaboração de histórias da Química em quadrinhos: uma abordagem dinâmica para o ensino médio*. In: 47º Congresso Brasileiro de Química, 2007, Natal. Anais eletrônicos do XLVII Congresso Brasileiro de Química. Available at <<http://www.abq.org.br/cbq/2007/trabalhos/6/6-351-196.htm>>. Accessed 12 april 2013.
- Arroio, A. (2010). Context based learning: A role for cinema in science education. *Science Education International*, 21(3), 131-143.
- Arroio, A. (2011). Comics as a narrative in Natural Science Education. *Western Anatolia Journal of Educational Sciences (WAJES), Special Issue: Selected papers presented at WCNTSE*, 93-98.
- Buckingham, D. (2003). *Media education: literacy, learning and contemporary culture*. Cambridge: Polity Press.
- Burden, J. (2007). Twenty First Century Science. developing an new science curriculum. *Science in School*. Issue 5 : Summer 2007. Available at http://www.scienceinschool.org/repository/docs/issue5_c21.pdf. Accessed 25 July 2013.
- Bybee, R. W. (1997). *Achieving scientific literacy: from purposes to practices*. Westport: Heinemann.
- DeBoer, G. E. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching*, 37(6), 582-601.
- Driver, R., Asoko, H., Leach, J., Mortimer, E., Scott, P. H. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher*, 23(7), 5-12.
- Ferreira, D. M.; Fraceto, L. F. (2009). Histórias em quadrinhos: uma ferramenta para o ensino de Química. In. *7o Simpósio Brasileiro de Educação Química*, 2009, Salvador. Anais

- eletrônicos do 7^o Simpósio Brasileiro de Educação Química. Available on <<http://www.abq.org.br/simpequi/2009/trabalhos/60-5668.htm>>. Accessed 12 april 2013.
- Grillo, S. V. C. (2012). Fundamentos Bakhtinianos para a análise de enunciados verbo-visuais. *Filologia e Linguística Portuguesa*, 14, 233-244.
- Laugksch, R. C. (2000). Scientific literacy: a conceptual overview. *Science Education*, 84(1), 71-94.
- Lyle, S. (2000). Narrative understanding: developing a theoretical context for understanding how children make meaning in classroom settings. *Journal of Curriculum Studies*, 32(1), 45-63.
- MacCloud, S. (1993). *Desvendando os quadrinhos*. São Paulo: Tasken.
- Microkids. *Software MK-Gibi*. Desenvolvido pela Microkids Informática Educacional. Versão 1.0. Disponível em: <http://mkgibi.software.informer.com/download/>. Accessed march 2013.
- Miller, J. D. (1983). Scientific literacy: a conceptual and empirical review. *Daedalus*, 112(2), 29-48.
- Moraes, R. (2003). Uma tempestade de luz: a compreensão possibilitada pela análise textual discursiva. *Ciência & Educação*, 9(2), 91-211.
- Norris, S. P.; Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, 87(2), 224-240.
- Norris, S.; Guilbert, M.; Smith, M.; Shahram, H.; Philips, L. (2005) A theoretical framework for narrative explanation in science. *Science Education*, 89(4), 535-554.
- Olson, J.C. (2008). *The Comic Strip as a Medium for Promoting Science Literacy*. Northridge, CA: California State University.
- Osborne, J. (2007). Science education for the twenty first century. *Eurasia Journal of Mathematics, Science & Technology Education*, 3(3), 173-184.
- Ritchie, S.M.; Tomas, L.; Tones, M. (2010). Writing stories on a socioscientific issue to enhance scientific literacy. *International Journal of Science Education*, 33(5), 685-707.
- Roth, W. M.; Barton, A. C. (2004). *Rethinking scientific literacy*. Routledge.

- Santana, E. R.; Arroio, A. (2012). Formação de professores na produção de histórias em quadrinhos (HQ) usando o computador. *Revista Tecnologias na Educação*, 6 (14).
- Santos, V. C. dos; Gouvêa, L. G. de; Arroio, A. (2013). Contributions of Brazilian project PIBID to pre-service chemistry teachers' education *in loco*. *Education: Policy, Management and Quality*, 1(13), 40-51.
- Strube, P. (1994). Narrative in the science curriculum. *Research in Science Education*, 24, 313-321.
- Tatalović, M. (2009). Science comics as tools for science education and communication: a brief, exploratory study. *Journal of Science Communication*, 8(4).
- Tan, E.; Barton, A.C.; Turner, E.E.; Gutiérrez, M.V. (2012). A Narrative Pedagogy for Critical Science Literacy. In: Barton, A.C.; Tan, E.; Turner, E.E.; Gutiérrez, M.V. *Empowering Science and Mathematics Education in Urban Schools*. University of Chicago Press.
- Tornero, J.M.P.; Varis, T. (2010). *Media literacy and new humanism*. Russia: UNESCO Institute for Information Technologies in Education.
- Yunus, M.M.; Salehi, H.; Embi, M.A. (2012). Effects of Using Digital Comics to Improve ESL Writing. *Research Journal of Applied Sciences. Engineering and Technology*, 4(18), 3462-3469.