ACTIO: Docência em Ciências
ISSN: 2525-8923

http://periodicos.utfpr.edu.br/actio

Story comics in teacher training: a multimodal approach to teaching chemistry

Natália Costa Rodrigues
natalia_costa@ufms.br
orcid.org/0000-0002-1578-1669
Federal University of Mato Grosso do Sul (UFMS), city of Campo Grande, state of Mato Grosso do Sul, Brazil.

Daniele Correia
d.correia@ufms.br
orcid.org/0000-0002-7068-7755
Federal University of Mato Grosso do Sul (UFMS), city of Campo Grande, state of Mato Grosso do Sul, Brazil.

ABSTRACT

This article addresses the potential of comic books in the context of chemistry teacher training. The objective was to assess the knowledge of chemistry teacher trainees regarding the elements that make up comic books and how they apply this knowledge to contextualize chemistry concepts. To this end, the students participated in the Comic Strip Creation Workshop (CSCW), which included theoretical activities on the features and uses of comic strips, as well as practical activities involving the creation of comic strips using the digital tools Bitmoji and Canva. The data collection instruments consisted of an initial questionnaire and productions developed by the students during the CSCW meetings. These data were analyzed based on content analysis methodology. The results indicate that the activities developed at the CSCW promoted the students' understanding of the elements that make up comics, preparing them to promote a contextualized approach and the articulation between chemistry knowledge and comics in the classroom. Finally, comic books proved to be a resource rich in educational potential for teaching chemistry, recommending their integration into basic education curricula and teacher training.
KEYWORDS: Comic Books; Digital Tools; Bachelor's Degree in Chemistry.

Histórias em quadrinhos na formação de licenciandos: uma abordagem multimodal para o ensino de química

RESUMO

Este artigo aborda as potencialidades do uso de histórias em quadrinhos (HQs) no contexto da formação de professores de química. O objetivo foi identificar os conhecimentos dos licenciandos em química sobre os elementos constituintes das HQs e a forma como aplicam esses conhecimentos para se contextualizarem os conceitos de química. Para isso, os licenciandos participaram da Oficina de Criação de Histórias em Quadrinhos (OCHQ), que contemplou atividades teóricas sobre as características e finalidades das HQs, além de atividades práticas envolvendo a criação de HQs por meio das ferramentas digitais Bitmoji e Canva. Os instrumentos de coleta de dados corresponderam a um questionário inicial e produções desenvolvidas pelos licenciandos durante os encontros da OCHQ. Esses dados foram analisados com base da metodologia de análise de conteúdo. Os resultados sinalizam que as atividades desenvolvidas na OCHQ promoveram a compreensão sobre os elementos constituintes das HQs, por parte dos licenciandos, preparando-os para promoverem uma abordagem contextualizada e a articulação entre conhecimentos de química e as HQs em sala de aula. Por fim, considera-se que as HQs se revelaram como um recurso com potencial didático enriquecedor para o ensino de química, recomendando-se sua integração nos currículos da educação básica e na formação docente.
PALAVRAS-CHAVE: Histórias em Quadrinhos; Ferramentas Digitais; Licenciatura em Química

INTRODUCTION

Comic books have an attractive and interactive approach that boosts teaching and learning chemistry. They mix text, images, and sometimes interactive features that make complex and abstract ideas easier to grasp. In the context of chemistry, comics can uncomplicate the learning process by displaying information in a sequential and aesthetically pleasing way, encouraging student engagement and interest in exploring content independently and critically by visually connecting theory and practice (Leite, 2017).

Furthermore, using comic books in the early training of teachers fosters innovative experiences in teaching and learning chemistry. By creating and using comics as a resource for teaching chemistry, trainee teachers experience learning by synthesizing information and presenting it in an attractive format and accessible language for students. The knowledge of how to teach is mobilized when the trainee teacher presents the comic book (their own creation) and builds on it to (re)structure their knowledge of chemistry with the students. This exercise improves their communication and argumentation skills, creativity, and authorship, preparing them to (re)think and critically reflect on teaching methods and how to adapt them to meet the diverse demands and learning profiles of students (Francisco Júnior; Gama, 2017).

Thus, by harmoniously combining text, images, and dynamic visual elements, comics provide a storytelling format that is both rich and accessible. In an educational context, such language can help address content in a simplified and engaging way, allowing students to develop critical reading skills, visual interpretation, and, above all, creativity. According to Vergueiro (2014a), comics can be harnessed to address scientific, historical, and literary themes playfully.

The use of comic books in initial teacher training has emerged as a strategy for combining didactic, technological, and social elements in the teaching-learning process. In this sense, Leite (2017) investigated the use of digital tools such as Pixton and ToonDoo to create comics in chemistry degree classes, showing that the experience, in addition to developing teaching skills, connects students to playful and interactive practices. The creation of comics by future teachers stimulates creativity, critical thinking, and the ability to develop more dynamic and meaningful teaching materials.

Research such as that by Kundlatsch (2019) and Gomes (2023) reinforces that using comics in teacher training transcends the scope of developing scientific content. Kundlatsch (2019) emphasizes the importance of literacy in comics, which entails understanding specific elements of comics, associated with the mobilization of teaching and cultural knowledge. Meanwhile, Gomes (2023) pointed out that even though future teachers tend to link comics to entertainment, they recognize their informative and educational potential when participating in comic-based teaching sequences. These practices also help teacher trainees make connections between science, society, and education, encouraging a critical and contextualized approach in their future classrooms.

Based on the above, this study aims to assess the knowledge of chemistry education students regarding the elements that make up comic books and how they apply this knowledge to contextualize chemistry concepts. To this end, a

Comic Strip Creation Workshop (CSCW) was offered, based on digital tools and active methodologies, actively engaging teacher training students in the process of creating comic strips.

COMIC BOOKS: HISTORY, CHARACTERISTICS, AND USE IN EDUCATION

Comic books are defined by Eisner (2010) as a sequential art form. They initially emerged as popular entertainment, but over time, they began to play an important role in education. In the early years, however, the use of comic books in teaching met with considerable resistance. Until the 1940s, intellectual society considered comics a threat to children's cognitive development, believing that they distracted attention from “good reading” and impaired school performance (Vergueiro, 2014a). During this period, any attempt to use comics in the classroom would be seen as inappropriate and irresponsible.

Despite this early resistance, by the 1940s and 1950s, some educators and governments began to realize the educational potential of comic books. In the United States during World War II, for example, comics were used for military training and technical instruction, proving their potential for conveying information in a simple and visual way (Ramos, 2009). At the same time, comics with educational content began to appear, focused on catechesis and the teaching of classical literature, such as the works of Shakespeare and Dickens (Vergueiro, 2014a).

In Europe, the introduction of comics into schools began in earnest in the 1970s. Gradually, they began to be added to textbooks as illustrations to complement the text. Even so, this approach was somewhat timid, due to concerns that parents and educators might reject the use of this form of language in schools (Vergueiro, 2014a). Over time, however, the success of comics as a teaching resource led to greater acceptance by publishers and educational institutions.

In Brazil, the use of comic books in schools also faced resistance for many years. Until the mid-1980s, they were seen only as recreational reading, with no educational value. Many teachers believed that comic books promoted “mental laziness” and distracted students from reading material deemed more relevant (Vergueiro; Ramos, 2009). However, starting in the 1990s, with the evaluation of textbooks by the Ministry of Education and the enactment of the Law of Guidelines and Bases for Education (LDB 9394/96), comic books came to be an official component of school curricula (Brazil, 1996). The creation of the National Curriculum Parameters (PCN) in 1997 marked an important milestone for the incorporation of comic books into literacy programs and reading practices, particularly in elementary and secondary education (Brasil, 1997).

In addition, government initiatives such as the National School Library Program (PNBE) began distributing comic books to public schools in 2007. These actions allowed comic books to establish themselves as an educational tool capable of making teaching more accessible and interesting for students (Vergueiro; Ramos, 2009).

Currently, comic books are recognized for their ability to promote visual literacy and encourage creativity and engagement among students. According to

the National Common Core Curriculum (BNCC), comic books are recommended for both the production and interpretation of texts in elementary and high school, covering a range of fields of knowledge (Brasil, 2018).

Comic books have unique elements that distinguish them from other forms of media, with the combination of text and images being a core feature that allows for pedagogical flexibility. Sequential art is the basis of this language, in which the organization of panels in sequence creates a fluid visual narrative that can be understood even with little or no text, thus enabling access by diverse audiences.

Panels, or vignettes, are the basic units of storytelling in comics. They visually arrange scenes and show the passage of time or changes in setting (Vergueiro, 2014b). Variations in panel size and shape help to heighten the action or highlight key moments in the story. Throughout these frames, speech bubbles are essential for expressing the characters' dialogues and thoughts. According to Eisner (2010), speech bubbles have evolved from simple outlines to more dynamic shapes, allowing for both the spoken word and the emotional tone of speech to be conveyed. The shape and typographic style of speech bubbles, such as the use of strong strokes for shouts or scribbles for whispers, add an extra layer of meaning to the verbal text.

Another striking feature of comic books is sound effects, which depict sounds graphically, such as "bang," "crash," or "zzzz," enriching the narrative and creating a sensory experience for the reader (Vergueiro, 2014b). These words help to heighten the reader's immersion in the story, allowing them to "hear" the sounds as they read. In addition, comics often use captions, usually located at the top or bottom of the panels, to provide additional information, such as descriptions of settings or timelines. The caption works as the narrator's voice, guiding the reader through elements of the story that are not fully explained by the images.

The relationship between image and text is enhanced by camera angles and shots, which help add depth and dynamism to scenes. Different shots — from close-ups to panoramic views — offer variations in perspective, highlighting key aspects of characters or settings (Vergueiro, 2014b). For example, close-ups emphasize subtle emotions or actions, while wide shots contextualize the scene within a larger setting. The protagonists and secondary characters are core elements of the story, and the visual attributes of the characters, such as iconic costumes in superhero comics, allow the audience to easily recognize them (Eisner, 2010).

Other visual resources include kinetic figures that stand for movement, like action lines around a running character, and visual metaphors that show ideas and emotions symbolically, like stars around a character's head after a hit (Vergueiro, 2014b). These visual elements enhance the expressiveness of the story, allowing the reader to interpret actions and emotions beyond what is explicitly stated in the text.

By incorporating comics into teaching, teachers manage to hold students' attention and foster meaningful learning, especially on subjects that are traditionally regarded as difficult or abstract in the fields of chemistry, physics, and mathematics (Vergueiro, 2014a; Ramos, 2009). Moreover, the use of comics

in teaching could help develop broad skills, such as scientific literacy and the formation of critical citizens.

Comic books also provide an opportunity to combine different disciplines and cultural contexts, thereby supporting an interdisciplinary approach to teaching (Vergueiro, 2014a). This versatility makes comics a promising resource in the classroom, sparking students' interest and facilitating content comprehension, as well as helping to develop crucial skills for critical thinking and problem solving (Ramos, 2009).

METHODOLOGY

This is a qualitative, participatory research study (Haguette, 1997; Brandão, 1990; Thiollent, 2008), which was submitted to and approved by the Research Ethics Committee (CEP) of the Federal University of Mato Grosso do Sul (UFMS), under Ethical Review Certificate (CAAE) number 80676824.7.0000.0021 and opinion number 7.257.935. To this end, a Comic Strip Creation Workshop (CSCW) was held for 12 chemistry students at UFMS, named L01 to L12.

The CSCW (Comic Strip Creation Workshop) consisted of 14 virtual meetings held via Google Meet between December 2023 and October 2024, each lasting an average of one hour. Throughout the workshop, the students participated in theoretical study sessions on comic books, practical activities for creating and analyzing stories, preparing lesson plans, and implementing the materials produced in school settings. Given the objective of this study, below is a summary of the activities carried out in the first four meetings, focusing specifically on the outcomes of the 2nd, 3rd, and 4th CSCW meetings.

The first meeting comprised three main parts: an overview of the researcher's academic background and experience in creating comic strips using Bitmoji and Canva, details of the research aims and schedule, and reading and discussing the Informed Consent Form (ICF), followed by a Q&A session and formalizing the voluntary participation of the 12 teacher training students.

The initial questionnaire was applied at the second meeting, aiming to assess the students' prior knowledge about the pedagogical potential of comic strips in chemistry classes and the key elements of a comic strip. Next, we took a theoretical approach to the features of comic books, covering their origins and historical evolution and discussing their main components, such as panels, captions, speech bubbles, sound effects, kinetic lines, and storytelling structure. We also discussed the potential of wordless comics, the role of sound effects in storytelling, and the relationship between layout and narrative. Finally, we analyzed layout errors and the use of speech bubbles.

Meanwhile, the first practical activity in the third meeting consisted of filling in the speech bubbles of a comic strip, with the students then creating stories for the scenes shown. In the second practical activity, the students used stickers of characters that they had created in the Bitmoji app to finish the comic, inserting these figures into different everyday scenes, such as eating a meal, interacting with animals, at the beach, drinking coffee, among other situations.

For the fourth meeting, students were given a practical assignment to create a comic strip using the Canva platform. The narrative provided for this task was organized into four panels, each presenting a sequence of events that unfolded both entertainingly and informatively.

The activities carried out in the second, third, and fourth CSCW meetings focused on creating multimodal content and integrating scientific information in an accessible and attractive way, fostering the development of technical and creative skills among participants. The main goal of these tasks was to stimulate the creativity of the students while introducing Bitmoji and Canva as a combination of useful digital tools to enrich visual stories.

The collected data were analyzed and interpreted based on the content analysis methodology proposed by Bardin (2011), which is structured in three stages: a) pre-analysis, b) material examination, and c) treatment of results, inference, and interpretation. According to the author, pre-analysis is an introductory step of organization, described as a moment of intuition and systematization of preliminary ideas, aimed at creating a more structured analysis plan. In this phase, the researcher establishes initial contact with the documents, allowing emerging impressions and guidelines to lead the process. Based on this first contact, the corpus is defined, that is, the set of documents to be analyzed.

In the material review phase, the decisions planned during the pre-analysis are put into practice. This step involves systematizing the information, including coding, segmenting responses, and categorizing, a process by which elements are classified according to their differences and regrouped based on common features. In this study, we used words (units of record) and phrases (units of context) extracted from the analysis of the occurrence frequency (presence or absence) of messages in the answers. In addition, the same text fragment was allowed to contain multiple units of context, broadening the scope of categorization.

Finally, in the results processing stage, categories were established based on common features in the elements analyzed. These units of record and context provided the basis for inferences and interpretations of the data, organized according to frequency of occurrence, always respecting the analysis criteria. This process enabled consolidating meaningful and valid outcomes for the research.

RESULTS AND DISCUSSION

The data analysis resulted in the following four main categories: “perceptions of the functionality of text and images in comics”; “visual and aesthetic appeal of comics”; “comics and their potential for a contextualized approach to chemistry knowledge”; and “comic creation processes.” Each of these categories was based on the responses of the teacher trainees to the initial questionnaire and on the work produced during the Comic Strip Creation Workshop (CSCW), highlighting different aspects of comic strip use in chemistry teaching.

PERCEPTIONS ON THE FEATURES OF TEXT AND IMAGE IN COMIC STRIPS

The first question in the questionnaire asked the students for their opinion on the need for text in comic books. Table 1 shows that the students' responses reveal different perceptions of how text and images can work together to convey meaning in comic books, particularly in the educational context of chemistry.

Table 1

Perceptions on the need for texts in educational comics

Participants	Examples of answers (context unit)	Register unit
L01 and L05	"Not necessarily. In chemistry comics, yes, but in general, some don't need text; the images are enough."	Content-dependent
L02, L04, L06, and L09	"No. If the visual elements are well presented, you can understand the narrative without text."	
L03 and L12	"It depends on the content; if it is little known or implied, some people may not understand it."	Visual effectiveness
L07 and L10	"The text should complement the drawings, facial expressions, and scenarios that describe the characters' intentions or emotions."	
L11	"No, it can be used in different ways."	Ambiguity without text
L08	"Yes, I lack expertise in the area, to be specific. It's just my personal opinion."	Complementarity

Source: Authors (2024).

Table 1 lists several opinions of the students regarding the function of text in comic books, grouped into different subcategories. In the subcategory "context dependence," some believe that the use of text varies according to the subject and students' familiarity with it, being necessary in contexts such as chemistry teaching. The subcategory "visual effectiveness" emphasizes that, for some, images can convey information without the need for text. In turn, the subcategory "ambiguity without text" suggests that in cases of more complex content, text is essential to avoid confusion. The subcategory "complementarity" highlights that text can enrich the story, providing details and meanings that images alone would not convey, while the subcategory "flexibility" stresses that text can be adapted according to the educational context. Finally, the subcategory "uncertainty" reflects a participant's uncertainty in defining the function of text due to a lack of familiarity with the topic.

Therefore, analyzing the answers shows that the students are aware of how text and images work in comics, which has a significant impact on teaching chemistry. These findings are consistent with the reports by Benedetti Filho and Benedetti (2020), who point out that the activities in their study contributed both to the initial training of undergraduate students, who actively participated in the use of comics in the classroom, and to the continuing education of teachers who had not previously experimented with playful activities in their teaching

practices. By recognizing the varying perceptions of the use of text and images, educators can make chemistry teaching more attractive, thus highlighting the importance of preparing teachers to use comics as a teaching tool.

Analyzing the students' answers about the role of sound effects in comic book storytelling showed that they had a good understanding of both what they are and the function they perform in comic books. Table 2 shows the students' answers, revealing their view of how these graphic sound elements are perceived in terms of their narrative function and pedagogical potential.

Table 2

Functions and pedagogical potential of sound effects in comic books

Participants	Examples of answers (contexto unit)	Register unit
L01, L02, L04, L06, L08, and L11	"Reproducing sounds in written form."	Sound
L10	"Sound effects provide an audible perception of what is happening in the story. Even though it is just a word when reading, I feel as if I am hearing the scene."	Sensory experience
L03 and L09	"Representing an action or feeling in the scene, without needing to be shown or detailed in depth."	Action
L07	"Emphasizing the emotions that appear in comics, bringing more impact."	Feelings
L12	"Sound effects help make comics more interactive and bring a certain 'realism' to the objects and stories being told."	Realism and interactivity
L05	"Allowing for a greater understanding of the stories."	Understanding

Source: Authors (2024).

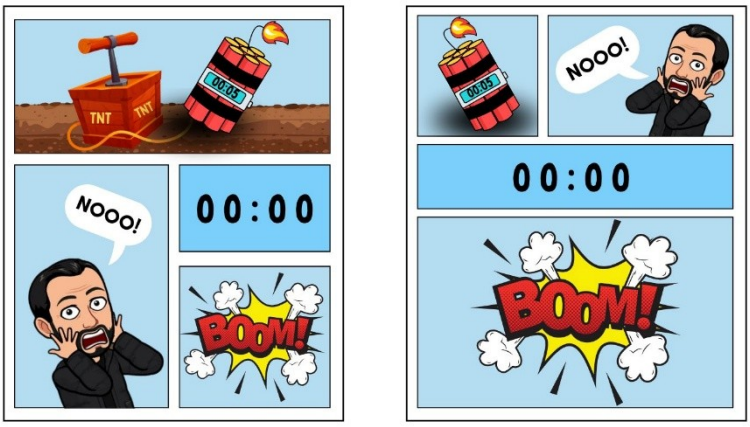
Participants pointed out several functions of sound effects, such as simulating sounds, illustrating actions, and expressing feelings, as well as adding realism, interactivity, and understanding to the narrative. By using sound effects to simulate sounds or highlight critical moments in scenes, educators can make classes more interactive and memorable. This understanding reveals the pedagogical potential of sound effects in teaching, suggesting that their integration into teaching resources can help explain concepts and make learning more accessible (Meireles, 2015).

VISUAL AND AESTHETIC APPEAL OF COMIC STRIPS

The students were asked to analyze two comic book layouts and choose and justify which one they considered most appropriate for telling the story presented, as shown in Figure 1. The answers reflect a diverse understanding of comic book layout techniques, especially in the use of larger panels to emphasize certain scenes.

Figure 1

Layout techniques in comic strips



Option A Option B

Source: Authors (2024).

In this regard, the composition of frames in mode A is more suitable for stories that require the building of tension and the emotional development of the character, as it allows the suspense to be built more gradually and the character's reaction to be explored in depth. In contrast, composition in mode B is better suited to fast-paced, high-impact scenes, which focus primarily on the climax and immediate reactions, without the need for much anticipation or prior emotional development.

> The goal of composing a frame is to arrange the elements so that they form a clear and harmonious whole and, if necessary, highlight the most important element of the scene (which could be a character, an object, an explosion, a scream, etc.). (Scoville; Alves, 2018, p. 267).

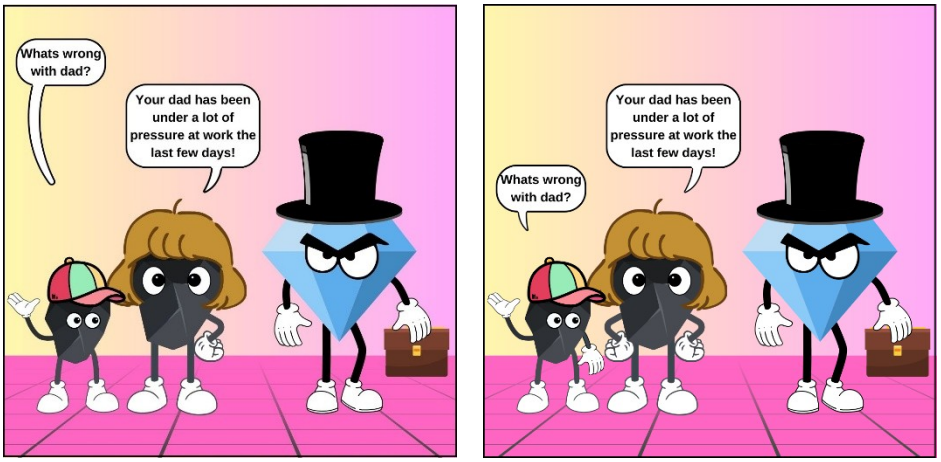
Perhaps influenced by the size of the frame, emphasizing the explosion scene in mode 2, all students considered this the most appropriate option for highlighting critical events. This unanimous choice reflects a clear understanding that larger frames and a well-organized sequence can enhance the expressiveness of a scene, increasing its emotional impact and perceived urgency. As noted in their justifications, the sequence of events in mode 2 was described as “a sequence of events that is easier to understand for a beginner comic book reader” (L03) and was also highlighted for providing “a more chronological order of events” (L06). In addition, the layout was praised for emphasizing the climax of the story, with participants recognizing that “the climax of the story (which would be the bomb countdown reaching zero and the explosion) is more prominent” (L07). Apparently, participants valued the ability of the layout in mode 2 to grab the reader's attention during the most dramatic moments of the story, allowing for a more direct and emotionally impactful visual reading.

The next question, shown in Figure 2, asked the graduates to spot a layout error in a specific comic strip, with the expected answer highlighting a

mismatched sequence of speech bubbles that could confuse the natural reading order, from left to right and top to bottom.

Figure 2

Detecting layout errors in comic strips



Source: Authors (2024).

The main layout error in the comic strip shown is the placement of the speech bubbles, which does not follow the natural reading order (left to right and top to bottom). The balloon with the answer “Your father has been under a lot of pressure at work lately!” is on the right and above, where the end of the conversation would normally be, but it answers the question in the balloon on the left, “What happened to Dad?”, which can confuse the reader. For greater clarity, the question should be further to the left and above, and the answer to the right or below, following the reading direction.

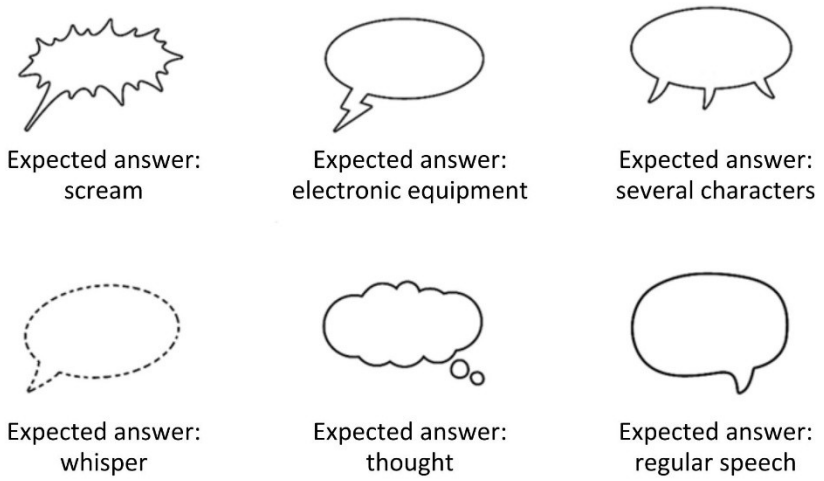
> [...] The speech bubble works, by its position, to indicate the order of the speakers, following the linear direction in which it is read. In other words, speech bubbles placed at the top left of the comic strip should be read before those placed on the right and below. (Vergueiro, 2014b, p. 57).

Only one student identified the error correctly: “The highlighted text is not the one that should be read first” (L01). The others did not notice the expected layout problem in the answer. This reinforces the importance of understanding visual and textual organization to ensure fluid reading. The difficulty of the students in identifying this specific error suggests a learning opportunity in teacher training, especially for the use of comics as a teaching resource.

Figure 3 features a practical question applied to undergraduates, designed to explore the functions of different types of speech bubbles in comic strips.

Figure 3

Narrative functions of speech bubbles in comics



Source: Authors (2024).

Most of the students correctly labeled the speech bubbles representing “shouting” with descriptions such as “a person shouting” (L02) and “loud voice, shout” (L05), indicating that they understood the emotional intensity conveyed. Eight participants got this function right, while four gave inaccurate answers, indicating a solid overall understanding, but with room for improvement.

The balloons denoting “whisper” were widely recognized by all students, with clear descriptions such as “character whispering” (S03) and “speaking softly” (S10). All students correctly interpreted this function, possibly because it is intuitive and frequently found in everyday stories.

However, the category of speech bubbles associated with “electronic equipment” caused more difficulties. Answers such as “an angry voice” (L02) and “an angrier speech bubble” (L07) suggest generic interpretations, without capturing the particular focus on sounds emitted by electronic devices. Only three students got this function right, while nine got it wrong, highlighting the need for more examples and explanations about this category.

Answers to speech bubbles for “multiple characters” and “thoughts” were accurate, with the students correctly recognizing when multiple characters were speaking simultaneously or when a speech bubble contained internal thoughts. Answers for “normal speech” speech bubbles also showed consistency, with participants correctly identifying them as representing direct and clear dialogue, such as “normal speech” (L02) and “dialogue” (L08). This accuracy suggests a good understanding of the most common function of speech bubbles in comics.

The range of answers and points of confusion reveals the need for more detailed teaching about the visual grammar of comics in teacher training programs, especially for those who plan to use these tools in the classroom. The ability to correctly interpret and use all types of speech bubbles is key to analyzing visual storytelling and creating teaching materials.

COMIC STRIPS AND THEIR POTENTIAL FOR A CONTEXTUALIZED APPROACH TO CHEMISTRY KNOWLEDGE

The students were asked to read the comic strip shown in Figure 4 and explain how they would use it in a chemistry class. Their answers reflect a wide range of educational applications, indicating a strong understanding of how to incorporate visual elements into science education.

Figure 4

Comic strips as a learning tool for teaching about changes in the physical state of water

Source: Feltre (2004, p. 16).

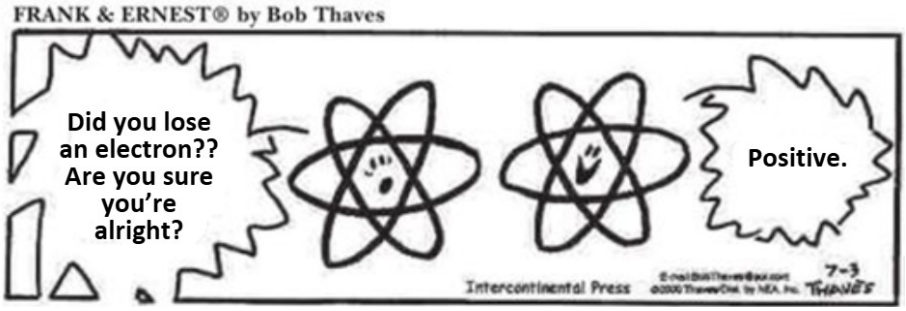
The comic strip shown in Figure 4 can be used creatively in chemistry classes to introduce concepts about the physical states of matter and changes of state, making learning more attractive to students. Similarly, Ornellas and Gomes (2020) point out that using comic strips to introduce chemistry concepts, including physical states of matter, helps contextualize scientific knowledge and enhance understanding of the topics covered.

The students acknowledged this potential, mentioning its application for teaching the physical states of water and their transitions. Some answers focused on traditional content, such as “lesson on states of matter, states of water” (L03), while others broadened the approach to include concepts such as “triple point of water and physical changes” (L05). In addition, they stressed the relevance of the comic strip for “explaining the three states of water and the change of physical state” (L06), demonstrating the flexibility of visual resources in chemistry teaching.

In addition, the students analyzed a comic strip illustrating concepts related to electric charges and ions, as shown in Figure 5.

Figure 5

Comic strips as a teaching tool for teaching about electric charges



Source: Feltre (2004, p. 137).

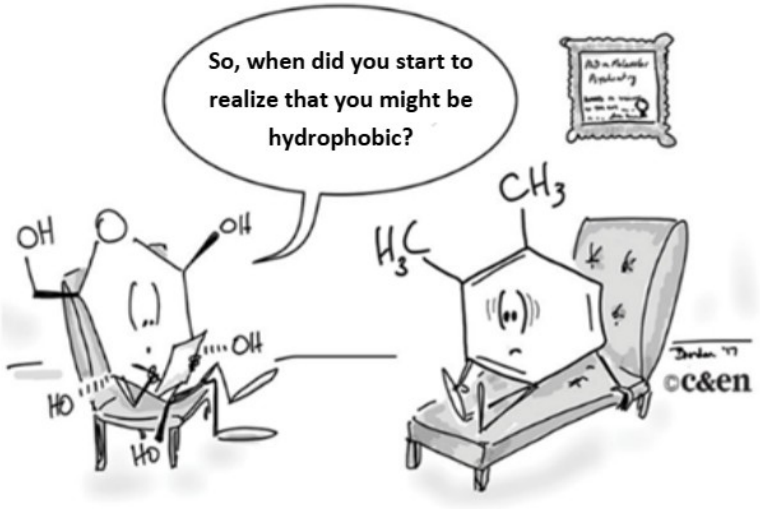
The comic strip shown in Figure 5 allows teachers to introduce or review chemistry concepts related to electric charges and ions in a fun and accessible setting. This approach is supported by Pilatti et al. (2021), who reported that using comic strips to teach electrostatics sparked students' interest and participation in the subject.

The students suggested several forms of using the comic strip to teach ions, electronegativity, and chemical bonds, highlighting their understanding of the potential of visual resources in teaching. Some answers highlighted its application to explain ions and cations, while others associated it with chemical bonds and the valence shell. These perceptions reinforce the idea that visual stories make abstract concepts more accessible, facilitating the understanding of atomic and molecular interactions.

The students were asked to consider the application of the comic strip shown in Figure 6 in chemistry classes, emphasizing the concepts of molecular polarity and its hydrophobic or hydrophilic properties.

Figure 6

Comic strips as a learning tool for teaching about polarity



Source: Adapted from https://cen.acs.org/sections/sketch-chemistry.html

The comic strip illustrates, in a visual, attractive, and easily understandable way, a key concept in chemistry: the polarity of molecules and their hydrophobic or hydrophilic properties. Complementarily, Francisco Júnior and Gama (2017) created a comic strip with an environmental focus, examining the impact of improper disposal of reused oil and fats, a recurring problem in Brazilian households. In the comics, the authors addressed terms such as immiscibility, polarity, and electric charges, showing that comics are a resource both for encouraging reading in the classroom and for introducing chemistry concepts and disseminating scientific knowledge.

The students provided a range of answers demonstrating their understanding of how comic strips can be used to teach complex concepts. In this regard, they recognized that comic strips could be used to discuss the polarity of molecules, with several answers highlighting their use in explaining how molecules interact based on their electrical properties. In addition, some participants suggested that comic strips could be used to address more specific topics, such as organic functions and hydrogen bonds, highlighting the versatility of visual aids in chemistry education.

The students' answers highlight the educational benefits of using comic strips in chemistry classes to promote greater student interest. In addition, the teacher trainees emphasized the potential of comic strips to explain complex chemistry concepts, making learning more accessible and less intimidating. This visual approach enables students to understand and awaken their interest in the content, thus becoming a valuable tool in chemistry teaching.

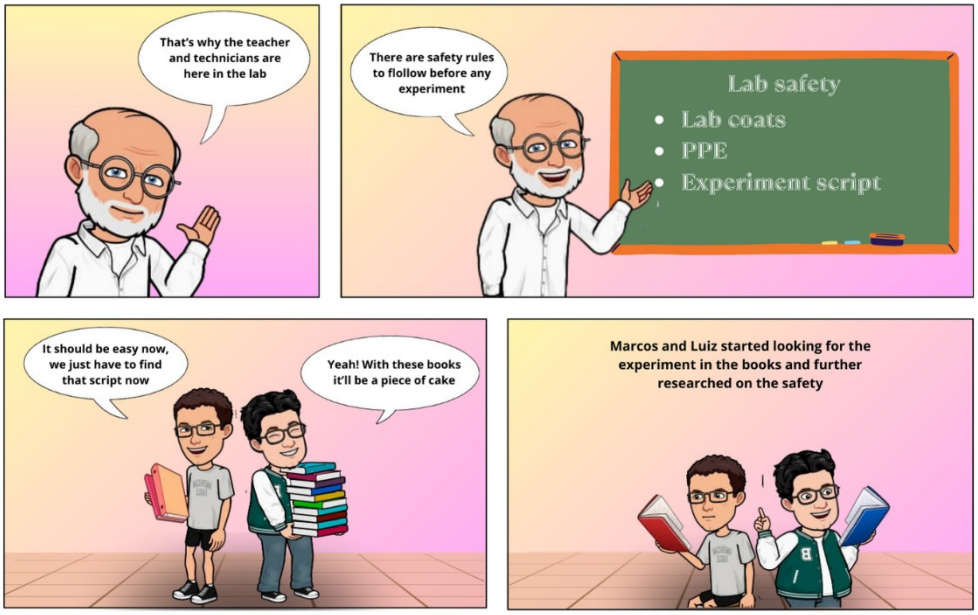
It is worth noting that it was discussed with the teacher trainees that personification (giving human feelings or attributes to inanimate objects), as shown in Figures 2 to 6, is not an obstacle, but rather a point for pedagogical discussion, being a feature that could be explored in the classroom. However, teachers must encourage students to engage in critical analysis, avoiding an inadequate understanding of the chemical concepts and phenomena represented in the comic strips. This approach sought to foster debates on how humorous resources, when critically addressed by teachers, do not undermine the pedagogical potential of comic strips.

COMIC STRIPS CREATION PROCESSES

During the CSCW, chemistry students participated in an activity in which they received a comic book with blank speech bubbles. They were instructed to create stories for the scenes presented, aiming to stimulate creativity and review chemical concepts in a playful and contextualized way. Although the stories varied in terms of scene context and chemical reactions, they all shared common themes, such as scientific curiosity, experimentation, and the importance of laboratory safety.

Figure 6

Story created by a student during the CSCW



Source: Participant L03 (2024).

Figure 7 features the comic strip created by L03, which addresses the importance of safety in the laboratory when conducting chemical experiments. In the story, the characters Marcos and Luiz show enthusiasm when starting an experiment, but due to a lack of guidance and unfamiliarity with basic safety rules, they end up causing an accident. The narrative unfolds with the intervention of the teacher, who reinforces the need to follow laboratory protocols, such as the use of PPE and prior consultation of experimental scripts. Other stories, such as those by L04 and L06, also focused on laboratory safety. The teacher trainees caused accidents by conducting experiments without supervision or failing to follow safety protocols.

It is worth noting that other comics by the students addressed reactions between alkali metals and water (L01, L05, L10). These reactions resulted in explosions due to the release of hydrogen gas and the formation of hydroxides. The presence of the teacher in the stories helped explain the exothermic nature of these reactions, highlighting the need for prior knowledge and supervision to avoid accidents. By emphasizing the reactivity of alkali metals and the precautions needed when handling them, these stories have a didactic purpose.

In turn, some stories (L04, L12) examined redox reactions. For example, the reaction between potassium permanganate ($KMnO_4$) and glycerin ($C_3H_8O_3$) illustrated a redox reaction that resulted in an explosion from the release of heat and light. The teacher explained the principles of these reactions, highlighting the importance of understanding the properties of the reagents and the associated risks. These stories illustrate how certain reagents can be dangerous if not handled correctly.

In other stories, the teacher trainees discussed concepts of chemical kinetics (L02, L11), such as the factors that affect the speed of reactions: temperature, contact surface, concentration, pressure, and catalysts. The teacher's explanations after the accidents helped students understand how these factors

influence reactions and the importance of studying these concepts before conducting practical experiments.

Thus, the narratives created by the students showcase a wide range of applications for chemical concepts and the relevance of laboratory safety. Furthermore, they highlight the creativity and potential of authorial writing as a pedagogical tool. In crafting their stories, the students exercised skills that extend beyond solving exercises and producing technical reports, practices that generally predominate in chemistry education. The activity allowed future teachers to develop communication, creative expression, and narrative skills, which are crucial for a more dynamic and humanized approach to teaching. This authorial exercise is enriching in a field where creative writing is rarely explored, often limited to the academic context, and only when writing the course completion paper.

The second CSCW activity consisted of completing comics with stickers of characters created by the students in the Bitmoji app, as shown in Figure 8, based on activity L01. The activity involved using images of the characters in various everyday scenes, such as eating, interacting with animals, at the beach, drinking coffee, and in other scenarios. The purpose was to allow the students to integrate their digital creations into the comics, demonstrating how technology can assist in the creation of teaching materials.

Figure 8

Incorporating custom Bitmoji characters into comics

Source: Participant L01 (2024).

Customizing characters allowed students to relate to their creations, making the storytelling process more meaningful. In Figure 8, L01 portrayed elements linked to their personal interests, such as reading, sports, and music, revealing a direct connection with the character that they created. Furthermore, the choice of skin tone and cultural representations reinforces the diversity of the Brazilian people and the importance of representation in education. This process supports

the growth of narrative skills, enabling authors to incorporate their experiences and imagination into their stories.

Technological integration was a key feature of this activity. The use of Bitmoji showed how digital tools can be incorporated into educational activities. In addition to making the activity more fun, using an app that is well-known and popular among young people helped connect the educational content with the digital world in which students live. This provided the student teachers with practical experience of how they can use similar technologies in their future classes.

Although it could have been challenging, familiarity with Bitmoji became a learning opportunity. The process allowed the students to develop digital skills while experimenting with narrative creation, enriching the educational experience.

In the third CSCW activity, the teacher trainees created a comic-style composition using the Canva platform. The storyline provided for this task was arranged in four panels, each featuring a sequence of events that unfold in a humorous and informative way, as shown in Table 3.

Table 3

Comic strip creation activity by Canva

Age	Percentage
Scene 1: – *Character A:* "What shall we have for dinner tonight?" – *Character B:* "How about a salad? It's nutritious and delicious!"	**Scene 2:** – *Setting:* Characters in the kitchen, ingredients in plain sight. – *Character B:* "Let's use onions, cut the onion."
Scene 3: – *Scene:* Sliced onions on the table and character A crying. – *Character B (laughing):* "Oops, watch out for the tears!" – *Character A (crying):* "These onions are trying to make me emotional!"	**Scene 4:** – *Character B explains:* "Onions are rich in sulfur compounds. Basically, when we cut them, the sulfur reacts with the water in our tears, producing sulfuric acid, which irritates our eyes." – *Character A (with teary eyes):* "Ah, so it's a chemical conspiracy by onions!"

Source: Authors (2024).

The activity engaged the students in creating multimodal content and encouraged them to integrate scientific information in an accessible and entertaining way. Using Canva as a graphic design tool allowed participants to acquire technical skills while harnessing their creativity in comic strip design.

In addition, the chosen storyline fostered the contextualization and understanding of chemistry concepts. This approach facilitates learning by combining visual and textual elements, making the information more understandable for different audiences. Figure 9 shows an example of a scenario for the aforementioned storyline, created by a student.

Figure 9

Example of a comic strip created by an undergraduate student at the CSCW

Source: Participant L07 (2024).

Analyzing the productions showed that the students created characters based on their own physical features, with guys playing male characters and girls playing female ones. This self-representation reveals how personally involved they were in creating the stories, highlighting their individuality and making the stories more relatable to their own experiences.

The comic strip in Figure 9 reflects the application of layout and narrative elements discussed in the workshop. The panels are organized in a logical and fluid sequence, making it easy to read. The settings range from a cozy living room to a kitchen with specific utensils, connecting the chemical content to everyday life in a visually appealing way. Moreover, well-defined facial expressions and postures complement the dialogue, conveying emotions and reinforcing the interaction between the characters. These aspects demonstrate the application of the concepts of graphic design, narrative structure, and pedagogical contextualization taught.

Like the second activity, the third helped build a range of skills, including visual communication, scientific understanding, and storytelling creativity. Choosing an everyday topic, like making a meal, and mixing it with funny scientific explanations, shows how comics can be a versatile educational tool.

FINAL REMARKS

This study fulfilled the goal of identifying chemistry undergraduates' knowledge of the constituent elements of comics and how they apply this knowledge to contextualize chemistry concepts. Comic strips offer a rich and visually appealing form of introducing complex scientific concepts, making chemistry learning more accessible and less intimidating. The experience of teaching and learning chemistry through comic strips prepares future teachers to experiment with new teaching methods, adapting to different learning styles.

Incorporating digital technologies, like character creation apps and graphic design platforms, highlighted the importance of adapting teaching practices to the digital environment. The methodology used at CSCW provided a practical and contextualized experience, showing the potential of tools like Bitmoji and Canva to spark creativity, develop storytelling skills, and enrich chemistry teaching.

The participants consolidated theoretical knowledge through practice and developed skills in visual narrative, design, and creativity, which are key competencies in contemporary education. The enthusiasm and openness of the students to the proposed activities reinforce the viability of comics as an educational resource. Given the educational potential of comics, especially for teaching chemistry, educational institutions should consider including and integrating comics into basic education curricula and teacher training, empowering students to face the challenges of modern teaching with confidence and creativity.

The analysis of the productions revealed that the students created characters inspired by their own physical features, reflecting their personal interests and experiences. This personalization highlighted their engagement and made the materials developed more authentic and meaningful. We hope that the findings of this study will broaden the debate on the use of comics in teacher training, encouraging autonomy, creativity, and the authorial production of teaching materials for chemistry education.

REFERENCES

Bardin, L. (2011) *Análise de Conteúdo*. São Paulo: Edições 70.

Benedetti Filho, E., Cavagis, A. D. M., & Benedetti, L. P. S. (2020). Divulgando a ciência em histórias em quadrinhos: investigações parciais e suas relações com a química. *Cidadania em Ação: Revista de Extensão e Cultura*, 3(2), 47-64. https://doi.org/10.5965/259464123247

Brandão, C. R. (1990). *Pesquisa participante*. 8. ed. São Paulo: Brasiliense.

Brasil. (1996). Lei nº 9.394, de 20 de dezembro de 1996. Estabelece as diretrizes e bases de educação nacional. *Diário Oficial da União*, Brasília, 23 de dezembro de 1996. http://portal.mec.gov.br/seesp/arquivos/pdf/lei9394_ldbn1.pdf

Brasil. Ministério da Educação e do Desporto. Secretaria de Educação Fundamental. (1997). *Parâmetros Curriculares Nacionais*. Brasília, DF: MEC/SEF. http://portal.mec.gov.br/seb/arquivos/pdf/livro01.pdf

Brasil. Ministério da Educação. (2018). *Base Nacional Comum Curricular* – BNCC. Brasília, DF. https://www.gov.br/mec/pt-br/escola-em-tempo-integral/BNCC_EI_EF_110518_versaofinal.pdf

Eisner, W. (2010). *Quadrinhos e arte sequencial* (4. ed.). São Paulo: Martins Fontes.

Feltre, R. (2004). *Química: Química geral* (6ª ed., Vol. 1). Moderna.

Francisco Junior, W. E., & Gama, E. J. S. (2017). História em quadrinhos para o ensino de química: contribuições a partir da leitura de licenciandos. *Revista Electrónica de Enseñanza de las Ciencias*, 16(1), 152-172. https://reec.educacioneditora.net/volumenes/volumen16/REEC_16_1_8_ex1148.pdf

Gomes, J. F. O. (2023). *Quadrinhos no ensino de ciências: compreensões de futuros professores de química*. (Dissertação de Mestrado). Universidade Estadual do Oeste do Paraná, Cascavel. https://tede.unioeste.br/handle/tede/6899

Haguette, T. M. F. (1997) *Metodologias qualitativas na Sociologia*. 5 ed. Petrópolis: Vozes.

Kundlatsch, A. (2019). *Enquadrando as histórias em quadrinhos na formação inicial de professores de química: possibilidades e limites*. (Dissertação de Mestrado). Universidade Estadual Paulista, Bauru. https://repositorio.unesp.br/bitstream/11449/181295/3/kundlatsch_a_me_bauru.pdf

Leite, B. S. (2017). Histórias em quadrinhos e ensino de química: propostas de licenciandos para uma atividade lúdica. *Revista Eletrônica Ludus Scientiae*, 1(1). https://doi.org/10.30691/relus.v1i1.748

Meireles, S. M. (2015). Quadrinhos e linguística: onomatopeias e interjeições e suas funções na narrativa em quadrinhos. In *A linguagem dos quadrinhos: estudos de estética, linguística e semiótica* (pp. 48-77). São Paulo: Criativo.

Ornellas, J. F., & Gomes, L. M. G. (2020). Uso de histórias em quadrinhos para ensinar ciências/química por meio dos superpoderes dos heróis. *Experiências em Ensino de Ciências*, 15(1), 558-573. https://fisica.ufmt.br/eenciojs/index.php/eenci/article/download/578/549

Pilatti, S. M., Fontes, A. da S., Ramos, F. P. & Santos, O. R. dos (2021). Possibilidades para o ensino de eletrostática através de uma sequência didática. *Revista Pontes*, 9, 110-126. Recuperado de https://l1nq.com/44GR3

Ramos, P. (2009). Histórias em quadrinhos: gênero ou hiper-gênero? *Estudos Linguísticos*, 38(3), 355-367.

Scoville, A. L., & Alves, B. O. (2018). Laboratório de artes visuais: fotografia digital e quadrinhos. Curitiba: *Intersaberes*.

Thiollent, M. (2008). *Metodologia da pesquisa-ação*. 16. ed. São Paulo: Cortez.

Vergueiro, W., & Ramos, P. (2009). *Os quadrinhos (oficialmente) na escola: dos PCN ao PNBE*. In . São Paulo: Contexto.

Vergueiro, W. (2014a). Uso das HQS no Ensino. In A. Rama, W. Vergueiro, A. Barbosa, P. Ramos, & T. Vilela, *Como usar as histórias em quadrinhos na sala de aula* (4. ed.). São Paulo: Contexto.

Vergueiro, W. (2014b). A linguagem dos quadrinhos uma "alfabetização" necessária. In A. Rama, W. Vergueiro, A. Barbosa, P. Ramos, & T. Vilela, *Como usar as histórias em quadrinhos na sala de aula* (4. ed.). São Paulo: Contexto.

Received: Feb. 19, 2025
Approved: Nov. 30, 2025
DOI: https://doi.org/10.3895/actio.v10n3.19953

How to cite:
Rodrigues, N. C. & Correia, D. (2025). Comics in teacher education: a multimodal approach to teaching chemistry. ***ACTIO***, 10(3), 1-23. https://doi.org/10.3895/actio.v10n3.19953